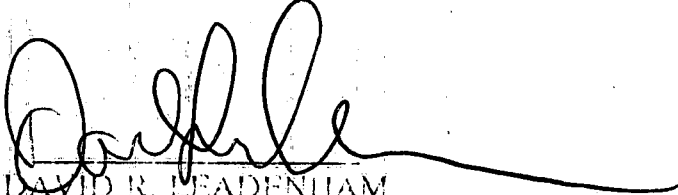


WORK PLAN FOR
REMEDIATION SERVICES
AT THE NL/DUTCHBOY PAINTS SITE
PERTH AMBOY, NEW JERSEY

SUBMITTED TO:
NL INDUSTRIES, INC.
CORPORATE ENVIRONMENTAL SERVICES
P.O. BOX 1090
WYCKOFFS MILL ROAD
HIGHTSTOWN, NEW JERSEY
BARRY L. EAMS - PRINCIPAL ENVIRONMENTAL ENGINEER

PREPARED BY:
OHM REMEDIATION SERVICES CORP.


DAVID R. LEADENHAM
OPERATIONS MANAGER

APRIL 1993
PROJECT _____

346810

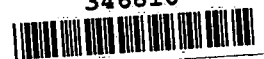


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1.0 INTRODUCTION

OHM Remediation Services Corp. is pleased to submit this work plan to NL Industries, Inc., in fulfillment of the Administrative Order On Consent (Index #____) known as the "Order" between NL Industries Inc and the US Environmental Protection Agency, Region II. The tasks associated with the scope of work will be performed concurrently to maximize on-site resource utilization and to provide a cost-effective, expedited schedule.

1.1 SCOPE OF WORK

The scope of work to be addressed is as follows:

- Premobilization Activities
- Mobilization
- Site Preparation
- Container Consolidation and Sampling
- Soil Areas of Concern
- Transformers
- Asbestos Removal
- Transportation and Disposal
- Cleanup
- Demobilization

2.0 TECHNICAL APPROACH

The following sections outline the methodology which OHM will employ to perform the scope of work, and to fulfill the Order requirements.

2.1 PREMOBILIZATION ACTIVITIES

OHM's project team will commence coordination of the project requirements, upon official notice to proceed. This pre-planning phase will consist of a pre-construction meeting at the project location. The pre-project meeting will have OHM's project manager, project supervisor, and NL's authorized representative(s) in attendance to confirm the scope of work and any administrative details, consisting of, but not limited to, the following:

- Specific Routing Requirements for Daily and Weekly Publishments
- Communication "chain-of-command"
- EPA interaction Coordination
- Equipment Staging Areas
- Current Site Traffic Patterns
- Waste Accumulation/Storage Areas
- Access Agreement with Facility Owner

2.2 MOBILIZATION

Personnel and equipment required to perform the scope of work will be mobilized from our Windsor, New Jersey location. Additional resources may be obtained from other divisional locations, if required.

Mobilization will commence promptly after receiving authorization to proceed. The following information outlines the proposed personnel and major equipment which will be mobilized during the project duration.

Personnel

1-Project Manager
1-Operations Supervisor
1-Foreman/Site Safety Officer
1-Equipment Operator
3-Clean-up Technicians
1-Sampling Technician Chemist

Equipment

1-Decontamination/Office trailer
1-Bobcat loader with grapppler attachments
1-215 Trackhoe
Air Operated pumps
Level B, C, D protective clothing
Sampling equipment
Air monitoring equipment

2.3 SITE PREPARATION

Upon completion of mobilization, site preparation activities will commence and will consist of the following:

- Delineation of work zones
- Set up personnel and equipment decontamination stations
- Prepare office and decontamination trailers
- Conduct site safety and work plan orientation with crew
- Post appropriate warning signs at required locations
- Commence daily/weekly planning and documentation activities
- Purchase required materials
- Obtain representative samples of anticipated waste streams and submit for required analysis
- Cover containers of chemicals which are subject to precipitation
- Locate water and electrical sources to be used (if required) during work activities
- Position equipment and disposal receptacles

2.4 CONTAINER CONSOLIDATION AND SAMPLING

This task objective is to remove the various sized containers located in the buildings identified in the Order in paragraph #33. Prior to the movement of any container, a visual inspection will be made to determine if existing or potential for leakage of the containers is evident. Containers which are leaking, or have integrity which is suspicious, will be placed into an overpack container prior to movement. Containers inside the building will be moved by cleanup technicians using drum carts, to floor voids, where they can be safely lowered to the ground floor. The former location of the drum will be visually inspected and contaminated debris will be removed and containerized for subsequent disposal. These containers will then be intercepted with equipment adapted with drum grappling devices. The machine will "grapple" the container and place it onto a pallet, keeping any labeling or markings facing the outside. After four containers are placed onto each pallet, polyethylene shrink wrap will be applied around the containers to prevent dislodging from the pallet during movement over the uneven terrain. A bobcat loader with fork attachments will then transport the full pallet to the staging/sampling area. Adequate space will be left between the rows of palletized containers in the staging area to allow access for technicians during container sampling activities.

Prior to drum movement, the proposed drum staging area will be prepared by placing geotextile fabric over the ground, to protect against contamination.

Containers having no contents may also be encountered during consolidation efforts. OHM will consider these containers empty, for disposal purposes. Technicians will verify that the containers are empty, move them, and neatly stage them for inspection and viewing.

As containers are accumulated within the staging area, initiation of the Sampling Program will commence and is designed to collect representative samples of the drum contents. The Sampling effort will utilize to the maximum extent possible the previous analytical data from the EPA TAT report. Specifically, we will acquire information that will aid in determining the presence and identification of the contaminants.

Using disposable PVC probes for solids and glass drum thieves for liquids, OHM will obtain samples from the containers. This will result in obtaining a single sample representative of the item sampled. Before obtaining a sample, technicians will document on a drum log the pertinent information about the item and contents to be sampled (e.g., size, volume/contents, color, labeling, or markings). For safety reasons, OHM will use a sparkless punch affixed to the hydraulic arm of the tracked excavator, or equivalent, to make ports in the drums. After the drums are sampled, the following will be done:

- A number will be affixed to each container (top and side).
- The drums will be sealed and covered to prevent intrusion from the elements. Any drums demonstrating reactivity (e.g., fuming, water/air reactive) will be segregated and staged separately from other drums.
- OHM will properly package the samples, complete chain-of-custody records, and transport the samples to the analytical laboratory.
- Copies of all drum logs and chain-of-custody records will be submitted to NL and copies submitted as part of our final report to the EPA. As an attachment, OHM has provided our Drum Inventory Log for your review.

SOIL AREAS OF CONCERN

Three areas that require the removal of battery grid metals and casing particles have been identified and are as follows:

<u>Area</u>	<u>Dimensions</u>
One	145' X 50'
Two	60' Radius
Three	190' X 70'

OHM proposes to separate surficial materials (soil, casings, debris, and terminals), by passing them through a screening device, consistent with paragraph #33 of the Order. Materials that pass through the screen will be returned to their origin, while oversized materials will be transported to a staging area constructed of polyethylene sheeting surrounded by an earthen-containment berm. The piles in the staging area will be securely covered with polyethylene sheeting which will drape down the pile and over the earthen berm to allow any rain water to flow off the sheeting to the exterior of the staging area.

Inspections will be frequently performed to ensure integrity of the polyethylene coverings, deficiencies will be immediately corrected.

Area of concern number three exhibited visual uniqueness in regards to quantity of casings evident for removal. This area will be addressed utilizing a combination of heavy equipment. A front end loader or equivalent will be used to scrape the casings to a central location where a "stock-pile" will be created. A trackhoe excavator will remove materials from the stock-pile and place them onto the portable screen.

Should conditions warrant, a secondary separation of the oversized materials to remove large rocks and debris, will be performed there by segregating mostly battery casings and grid metal for offsite disposal. This alternative, both operationally and economically, will be evaluated based upon actual field observations made during screening operations. Casings will be landfilled prior to the May 8, 1993 land ban. Accumulated lead will be sent off-site for recycling.

During premobilization activities, the three areas requiring removal will be delineated by field markers. Sections within the three areas which have minimal casings or grid metals for removal will be remediated by technicians manually picking up the visible items of concern.

2.6 TRANSFORMERS

Commencement of the transformer removal task will be to obtain and verify the following pertinent information:

- Unit dimensions (height, length, width)
- Approximate unit weight (void of fluids)
- Quantity of fluid
- Polychlorinated biphenyl concentration
- Access/removal restrictions (if any)

Consolidation and review of this information will enable offsite disposal of the 12 (twelve) transformers.

To facilitate removal operations, and to optimize disposal options, OHM will drain and consolidate all transformer fluids into appropriate D.O.T. shipping containers, air driven pumps will be used to remove the fluids. The drained transformer carcasses will be removed from their present locations using standard rigging methods, and placed onto appropriate transport vehicles. Visual inspection revealed one area, adjacent to transformers, that requires surface debris removal. This area is comprised of approximately 2000 square feet of floor space. OHM will manually remove and containerize accumulated dirt and debris. OHM technicians will use long handled scrapers and shovels to remove the surface accumulation.

During this, as well as for other material handling tasks, OHM will provide the appropriate equipment to mitigate emergencies (i.e., spill, fire). These will be in place prior to commencing each task.

Equipment to handle spills, fires, and toxic vapor releases will be stationed adjacent to the required work areas. Below is a listing of on-site equipment and materials for specified emergencies.

<u>Emergency Condition</u>	<u>Equipment or Material</u>	<u>Purpose</u>
Spill	Absorbent pads, shovels (sparkless), disposable pumps	Soak up liquids, remove solids Containerize liquid spills
	Lime/Soda Ash	Neutralize/absorb
Fire	100# wheeled extinguisher Piles of sand OHM on-site response teams	Extinguish fires Smothering
Vapor	Piles of sand Wind sock Air Monitoring	Smother source Vapor direction Identification

2.7 ASBESTOS REMOVAL

The boiler room, located in building 4, 3rd floor, has suspect asbestos insulation in varying degrees of friability. OHM will remove all the insulation from the confines of the boiler room in accordance with all applicable regulations governing asbestos abatement, and its subsequent disposal. The following outline depicts the operational flow of events for asbestos abatement in the boiler room:

- Post appropriate asbestos warning signs
- Erect temporary personnel decontamination station(s) contiguous to work area
- Seal structure voids within the boiler room using plywood and polyethylene sheeting
- Install and maintain negative air handling system
- Remove and bag all insulation while adequately wetting
- Wash down all interior surfaces and equipment; containerize and or filter washwater
- Obtain final air clearance
- Final lockdown with application of encapsulant
- Tear down containment
- Dispose of materials

Similar practices will be employed by technicians in areas where small sections, or boxes of virgin insulation exist, that require removal as asbestos containing. Sections of insulation will be wet using low volume/low pressure applicators prior to handling, to eliminate potential for airborne fiber releases. All materials will be double bagged, labelled, and disposed in accordance with all applicable regulations.

2.8 TRANSPORTATION AND DISPOSAL

OHM's transportation and disposal (T&D) procedures will be in compliance with all current regulations and laws governing hazardous waste. OHM's T&D manager will initiate activities by reviewing the analytical results from composite (bulk) samples from each wastestream, which were obtained upon our arrival to the site. Information from the analytical report will be relayed onto a waste profile, which will be forwarded to the disposal firm(s).

Preparation of the waste for disposal is contingent upon the disposal firm's requirements. All waste shipments will be properly packaged, loaded, and manifested to the approved facility. Prior to shipping a waste, the receiving state agency will be notified. Based upon analytical results and final disposal acceptance, OHM will formulate and submit cost saving options such as bulking of compatible wastestreams and on-site treatment options, as well as reclamation options. Below is a listing of anticipated wastestreams with corresponding offsite disposition(s):

<u>Wastestream</u>	<u>Disposal Option</u>
PCB (Mineral Oil)	Incineration
Transformers	Carcass Flushing Carcass salvage or landfill
PCB Debris	Landfill
Lead contaminated debris/casings	Landfill
Battery Grid Metals	Thermal Recovery
Bldg. Contents (Containerized Waste) (55 Gallon Container)	Landfill Incineration - Solids - Liquids
(Bulk Shipment)	Landfill Incineration
Asbestos Containing Materials	Landfill

2.9 CLEANUP

During cleanup operations, OHM will install a concrete curbing adjacent to the soil area of concern #3 to deflect run-on waters. Upon completion of the scope of work, technicians will clean all equipment used during the performance of work.

2.10 DEMOBILIZATION

Upon verification of scope of work completion, personnel and equipment will be demobilized to their respective origins.

2.11 DOCUMENTATION

As part of normal operating procedures, and in compliance with the Order, OHM will provide documentation of all Site activities. Below is a listing of the types of documentation to be provided, their frequency of submittal, and respective contents/purpose:

<u>TYPE</u>	<u>SUBMITTAL FREQUENCY</u>	<u>CONTENTS/PURPOSE</u>
Daily Report	Weekly	Pertinent weather information Quantitative work performed Unusual conditions Subcontractor Services Submittal Tracking Discussions/Meetings Financial Tracking Subsequent planning List of results received
Foreman's Workplan (Daily)	Weekly	Task specific tracking Task specific resources Task production/accountability
Weekly Planner	Weekly	Task duration, task overlap Resource requirements Schedule comparison Forecast by task
Final Report	One time (Post Project)	Summary of operations Analytical Transportation Disposal Waste quantities Air monitoring data

2.12 Community Relations

Community Relations: OHM recognizes that situations may warrant the dissemination of information to the public regarding activities at the Site. The community relations program will be utilized in such situations. The program would provide information with regard to OHM's work and the schedule status of this work at the Site. The program will be continually updated and available at the Site. Finally, at the request of the EPA On-Scene Coordinator, OHM will participate in public meetings where the work may be discussed.

3.0 PROJECT SCHEDULE

APPENDIX A - DRUM INVENTORY LOG



OHM

DRUM INVENTORY LOG

Form 0068
Field Tech. Svcs.
07/88

DRUM NO. _____

PROJECT INFORMATION

PROJECT LOCATION _____ PROJECT NUMBER _____
 PROJECT CONTACT _____ PHONE _____
 LOGGER _____ SAMPLER _____
 WEATHER _____ DATE _____ TIME _____

DRUM TYPE: FIBER ☐ STEEL ☐ POLY ☐ STAINLESS STEEL ☐ NICKEL ☐
 POLY-LINED ☐ RING TOP ☐ CLOSED TOP ☐ OVERPACKED ☐
 DRUM CONDITION: MEETS DOT SPEC ☐ GOOD ☐ FAIR ☐ POOR ☐
 DRUM SIZE: 88 ☐ 55 ☐ 42 ☐ 30 ☐ 16 ☐ 10 ☐ 5 ☐ OTHER _____
 DRUM CONTENTS: AMOUNT FULL ☐ 1/4 ☐ 1/2 ☐ 3/4 ☐ < 1/4 ☐ MT ☐

PHYS. STATE					COLOR	CLARITY			LAYER THICKNESS	FIELD ANALYSIS			
L	L	S	S	S	USE STD COLORS	C	C	O	INCHES				
AYERS	QUID	SOLID	HELL	LUDDGE		LEAR	LOUDY	PAQUE					
T										PH _____ SU _____ PID _____ ppm			
M										DOSIMETER _____ mrem/yr			
B										OTHER _____			

DRUM LABELS/MARKINGS

DOT HAZ _____ UNNA _____

MFG NAME _____

CHEMICAL NAME _____

ADDITIONAL INFORMATION _____

LABORATORY COMPATABILITY DATA

☐ Mark if Physical State and Color matches the above information. If not, stop analysis and notify project contact. Further work will not be paid for.

COMPATABILITY CAT. _____

ANALYST: _____

RADIATION: POS ☐ NEG ☐ _____ mrem/yr

DATE PERFORMED: _____

PHYSICAL STATE					COLOR	CLARITY			WATER SOL.	REACT	PH	REL. SOL.	PER.	CHG.	CH	SA	REL. SOL.	FLAME POINT	PCB IN OIL	DOT HAZ	
L	L	S	S	S	USE STD. COLOR	25°C	25°C	25°C	SOLUBILITY S. FL. I DENSITY IN GR L	A - AIR W - WATER	STD UNIT	0 OR 1	+	-	+	-	+	-	°C	+	-
T																					
M																					
B																					

Comments: _____

CB Conc. _____ PPM Flash Point _____ °C Compatibility Comp. Bulk # _____

Lab Reviewer: _____

Data Review Date: _____

Field Reviewer: _____

Field Review Date: _____

APPENDIX B - DAILY REPORT

DAILY REPORT

Report No. _____ Date _____

Project No. _____ Delivery Order _____
OSC _____

Description of Delivery Order _____

Location of Work _____

Weather _____ Rain _____ Temp. Min. _____ Max. _____

Work Performed Today by OHM _____

Work and Services Performed today by Subcontractors _____

Exceptions/Unusual Conditions Noted by OHM Supervisor _____

Request for Changes in Method or Scope and Specific
Directions Received from OSC _____

Documents Submitted
Document _____ TO _____

NOTE Use continuation sheets if necessary for clear
explanations.

Meetings Held, Subject Matter, Directions/Decisions

*Daily Estimated Expenditure _____

*Estimated Expenditure Total To Date _____

Planned Activities for Subsequent Day

Signed _____

ONN Supervisor

Signed _____

OSC

* These are estimated expenditures based on field data; actual expenditures may vary based upon audit and actual subcontractor invoices.

NOTE Use continuation sheets if necessary for clear

APPENDIX C - FOREMANS WORKPLAN

FOREMAN'S WORKPLAN

FOREMAN: _____

DAY: _____

DATE: _____

REPORT # _____

CREW

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

ASSIGNMENT

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

SPECIAL EQUIPMENT NEEDED: _____

UNUSUAL CONDITIONS TO NOTE: _____

PRODUCTION GOALS: _____

FOREMAN'S NOTES: _____

APPENDIX D - WEEKLY PLANNER

WEEKLY PLANNER

WEEK BEGINNING: _____

PREPARED ON: _____

[illegible]

ESTIMATED DAYS TO COMPLETE TASK

[illegible]

DAYS USED TO DATE PER TASK:

[The page contains several horizontal black bars, likely representing redacted information or scanning artifacts.]

APPENDIX E - PROFESSIONAL PROFILES

PROFESSIONAL PROFILE

FRED HALVORSEN, Ph.D., P.E., C.I.H.

TITLE

Vice President, Health and Safety

ACADEMIC BACKGROUND

Ph.D., Chemical Engineering, University of Maryland, 1970

M.S., Chemical Engineering, University of Maryland, 1970

B.S., General Engineering, Honors, United States Coast Guard Academy, 1964

EXPERTISE

Management of environmental affairs; oil, hazardous-materials, and liquefied-gas transportation; emergency management of hazardous-materials incidents; training in hazardous materials; environmental health and safety; and industrial hygiene

Dr. Halvorsen joined OHM in 1984 as director of Health and Safety, following a 20-year career in the United States Coast Guard. His experience has included all aspects of health-and-safety management, management of hazardous-materials incidents, and interfacing with clients and regulatory agencies on matters relating to health, safety, and industrial hygiene. This experience includes supervision of a nationwide staff of 20 professional personnel responsible for approximately 40 hazardous-waste sites. The duties of these personnel include site safety, health-and-safety management, industrial hygiene, hazardous-waste management, and safety training.

He assumed his present position as vice president of Health and Safety in 1986. In this position, he oversees corporate safety, medical-surveillance programs, industrial-hygiene management, preparation and review of site-safety plans, establishing and overseeing safety and environmental audits, safety-equipment selection, and safety-training requirements for OHM and other related companies under OHMC.

His specific duties have included preparation of numerous site-safety plans for hazardous-waste sites, acting as a site-safety officer/site-safety observer at major hazardous waste-site emergencies, supervising and conducting environmental audits, and training personnel in all aspects of emergency-response incidents involving oil, hazardous materials, and hazardous waste.

Dr. Halvorsen's previous experience in the United States Coast Guard included commercial-vessel and mobile offshore oil drill-rig inspection, accident investigation relating to fire and explosion, and responding to spills of oil and hazardous materials as a federal on-scene coordinator. He has served as an expert witness, a national spokesman on hazardous-materials issues, and has been a technical advisor at numerous accidents involving fire, explosion, and release of hazardous material. He served at the United States Coast Guard headquarters in Washington, D.C., in various technical assignments related to the transportation of oil, chemicals, and liquefied gases; and later served as the chief, Marine Safety School, at the Coast Guard Training Center in Yorktown, Virginia, where he established and taught a course in hazardous-materials safety.

He has served as an advisor to the National Academy of Science on formulating a policy for the safe transportation of hazardous materials. He has supervised technical staff, a technical school, and operational entities.

**PROFESSIONAL
REGISTRATIONS,
CERTIFICATIONS,
& AFFILIATIONS**

Professional Engineer; expert witness
Certified Industrial Hygienist (comprehensive practice)

Member, United States Coast Guard Academy Alumni
Association

Member, American Institute of Chemical Engineers
Diplomat, American Board of Industrial Hygiene

Member, Tau Beta Pi (National Engineering Honorary
Society)

Member, Sigma Xi (Research Society of America)

PUBLICATIONS

Dr. Halvorsen has published 40 articles on topics related to safe transportation of hazardous materials including fire and explosion hazards, emergency response, safety of emergency-response personnel, and spill cleanup. His experience includes numerous participations as organizer, session chairman, and speaker at meetings and seminars.

TODD A. KING

Mr. King joined OHM in 1992 with over 6 years experience in on-site environmental remediation services. As a site supervisor, he is responsible for directing multidisciplinary field crews, developing work and safety plans, daily cost reporting, client interface, subcontractor management, construction, and equipment operation. Mr. King has supervised projects involving soil excavation, tank removals, decontamination/demolition, drum overpacking, and emergency response cleanup of oil spills.

Experience

Site Supervisor: Mr. King is currently supervising on-site operations for a decontamination project in Sayerville, New Jersey. The project involved bulking approximately 2,000 gallons of PCB oil from transformers, decontamination and demolition of a cement pad, and hazardous waste disposal. Mr. King is supervising five recovery technicians, is responsible for maintaining health and safety procedures on site, is coordinating work with the client and preparing daily work plans and cost reports.

Site Supervisor: Mr. King supervised on-site operations at an oil refinery in Carteret, New Jersey. The project involved the excavation of a 1,000 gallon UST, dewatering, radiological surveying, cleaning/decommissioning a 550,000 gallon AST, monitoring well installation, and recovery sump installation. Petroleum hydrocarbons and ignitable oil products were the contaminants found on site. He coordinated tank removal notifications, confined space entry requirements, managed drilling and disposal subcontractors, and directed the sampling and analytical program. Mr. King supervised one foreman, one equipment operator, two recovery technicians, and one hydrogeologist.

Site Supervisor: In January 1993, Mr. King supervised the on-site operations at a motor facility in Langhorne, Pennsylvania. His crew of three recovery technicians decontaminated and sanitized medical infectious waste from a tractor-trailer. He determined protective equipment levels and coordinated work with local regulatory officials.

Site Supervisor: Mr. King supervised the on-site operations for a chemical company in Bridgeport, New Jersey. His crew of two recovery technicians decontaminated (hydroblasted) machinery and equipment. He interfaced with the client regarding utility shutdowns, conducted daily safety meetings and managed the disposal of approximately 1,000 gallons of wastewater.

Site Supervisor: Mr. King supervised on-site operations at a chemical manufacturing facility in Old Bridge, New Jersey. The project involved decontaminating a highway contaminated with 5,000 gallons of hydrochloric acid. Mr. King supervised product containment measures, spill site assessment, air monitoring, product collection, and neutralization and decontamination of affected surfaces. He managed the project in conjunction with state regulatory officials. He supervised six recovery technicians for this project.

Site Supervisor: For a NJDEPE project, Mr. King supervised the overpacking of three 55-gallon drums of unknown contaminants. He supervised two recovery technicians in safely handling, sampling, and arranging for disposal of the drums.

Site Supervisor: In November 1992, Mr. King supervised the on-site operations at a oil facility in King of Prussia, Pennsylvania. The project involved excavating diesel fuel contaminated soil, and recovering product from approximately 1 mile of stream. Mr. King supervised one truck driver, five recovery technicians, and one equipment operator. He directed boom placement and recovery actions in conjunction with PADER representatives, assessment and sampling procedures, and loadout and disposal of contaminated soils. He also provided daily communications and cost reporting to the client.

Hazardous Site Mitigation Specialist: At a site in Burlington, New Jersey, Mr. King provided regulatory oversight to cleanup following a 2,000-gallon waste oil spill. He supervised contractor personnel in cleaning affected highway, excavating contaminated soil, and performing containment and recovery actions on a waterway. He directed remedial activities, provided safety oversight, approved and verified daily cost reports, and interpreted analytical data to guide cleanup efforts.

Hazardous Site Mitigation Specialist: Mr. King managed investigation and remediation activities at a auto salvage site in Marlboro, New Jersey. He reviewed and approved the investigation work plan, and oversaw test trenching and monitoring well installation activities. Based on the findings of the investigation, Mr. King authorized and coordinated the removal, sampling, and disposal of 300 drums and the excavation of soil contaminated with heavy metals and petroleum hydrocarbons.

Hazardous Site Mitigation Specialist: Mr. King supervised contractor personnel in the removal of 500 drums at a site in Edison, New Jersey. He reviewed work and safety plans, validated cost reports and invoices, and oversaw analysis and disposal of the drums. He also directed a ground-water investigation to determine the impact from leaking drums.

Senior Environmental Specialist: After a pipeline spill in Mt. Holly, New Jersey, Mr. King supervised cleanup of a major waterway. Over 3,000 gallons of JP-4 jet fuel were released during the incident. He coordinated contractor personnel in the sampling, analysis, excavation, and disposal of 3,000 cubic yards of soil. He also directed boom placement and vacuum recovery actions on the river. Additionally, he oversaw the safety monitoring program.

Senior Environmental Specialist: Mr. King supervised the removal of USTs and cleanup of No. 2 fuel oil in Medford Lakes, New Jersey. He oversaw tank monitoring operations, the confirmation sampling program, and directed ground water product recovery and excavation actions based on analytical results. He also approved the tank removal report.

Academic Background

B.S., Microbiology, Penn State University, 1986

Specialized Training

OHM Site Supervisor's Training, 1992
NJDEPE Project Implementation, 1991
RCRA Land Ban Restoration Training, 1990
USEPA Groundwater Recovery Methods, 1990
NJDEPE 8-hour OSHA Update, 1988-1992
USEPA Haz Waste Investigator Training, 1989
NJDOT Haz Mat Haulers Course, 1989
NJDEPE Air Monitoring, 1988
USEPA Haz Mat Response Training, 1988
NJDEPE 40-hour OSHA, 1987
RCRA Inspector Training, 1986

DARRYL C. MIKE

Mr. Mike is a certified health-and-safety technologist with over 16 years' diverse experience in environmental health and safety, industrial hygiene, analytical chemistry, and personnel management. His background includes development, implementation, and management of site-specific safety plans and air-monitoring and air-sampling programs. Additionally, he is experienced with establishing various levels of personal protection programs, and preparing and presenting classroom and on-site safety training materials.

He has advanced knowledge of TSCA, RCRA, CERCLA, SARA Title III, and other federal, state, and OSHA regulatory programs. He conducts safety audits and inspections to ensure OHM's compliance with these regulations, and prepares safety assessments and reports.

Experience

Mr. Mike's on-site experience includes soil excavation; dewatering; compressed gas cylinder identification, handling, and neutralization; hazardous-waste transportation and disposal; drum recovery and repackaging; asbestos-abatement; wastewater and groundwater treatment; PCB cutting and bulking; contaminant-sampling; underground recovery; filtration; and compatibility testing.

Examples of Mr. Mike's project experience are provided below:

- Site-safety supervisor for the remediation of a 5-acre Superfund site for the New Jersey Department of Environmental Protection (NJDEP). This project involves tank cleaning, sludge removal, process pipe removal, drum-staging, sampling, and disposal. Also performed was the installation of an on-site water-treatment system for 30,000 gallons of water contaminated with PCBs, oil products, volatile organics, and heavy metals. Mr. Mike ensured the site-safety plan implementation and compliance during this project and supervised a crew ranging in size from 10 to 15.
- Mr. Mike had initial responsibilities for the development, implementation, supervision, and enforcement of the health-and-safety plan for a project involving excavation of a building foundation and soil contaminated with PCBs and VOCs. He established levels of protection, conducted air- and personal-monitoring, implemented decontamination procedures, set up work areas, arranged for site security, and developed and managed a medical program for subcontracted nonhazardous union workers consisting of 15 laborers, 10 steel workers, and 15 equipment operators.

At the onset of the excavation of the building foundation, the client requested that Mr. Mike be responsible for all on-site environmental activities which included, in addition to excavation, soil-sampling and analysis and arranging for transportation and disposal of contaminated soil.

His additional responsibilities included supervision of a 10-man crew consisting of a supervisor, safety officer, three operators, and five recovery technicians involved in excavating the footing and foundation of a large warehouse/store. Over 4,000 tons of PCB- and VOC-contaminated soil were excavated. The excavated area was backfilled and a french drain was installed to prevent future flooding of the area.

- Mr. Mike served as site-safety officer for the insulation-removal and facility-decontamination project at a 100-acre chemical manufacturing site in West Virginia. He was responsible for developing, implementing, and supervising the air-monitoring program for asbestos removal and overall site-safety procedures, including medical surveillance for OHM project personnel. Project personnel included a project manager, a site supervisor, nine foremen, a transportation-and-disposal coordinator, an engineer, and 70 recovery technicians.
- Mr. Mike served as site-safety officer responsible for developing, implementing, and supervising the health-and-safety plan, including Level C personal protection program for the decontamination of a ten-story, PCB-contaminated building that was part of a nine-building complex slated to become luxury condominiums. The health-and-safety aspects were complicated by the many construction and inhalation hazards caused by PCB dust. On-site cleanup crews ranged in size from 12 to 69. Strict cleanup criteria were established at 5 ppm or less at a 3-inch depth and a nondetectable level of PCBs at the surface using hydrolasering and scarification techniques since the facility was to be used for housing.
- Served as site-safety officer for drum recovery, staging, sampling, transportation, and disposal for the USEPA. This project also entailed on-site treatment of acids and bases, and bulking of unknown drums. Mr. Mike was also responsible for directing a team of 11 operations personnel during this project.
- As site-safety officer, Mr. Mike instituted and oversaw the implementation of site-safety procedures for a project involving steam-cleaning of a junkyard which required PCB decontamination, air-monitoring, and the installation and operation of a wastewater-treatment system. He had overall site-safety responsibility for the crew of 15.

Academic Background

B.S., Management Science/Chemistry, Kean College, 1980
A.A.S., Chemical Technology, Union College, 1975

Specialized Training

OSHA site-safety and related training
Inland Oil Spill Control Training, Texas A&M University, 1989
Industrial Safety Course, Travelers Insurance Company, 1988
OHM Supervisory Management Training, 1988
OHM Asbestos-Abatement Training, 1988
Industrial Hygiene Course, Travelers Insurance Company, 1987
OHM Site-Safety Officer Training, 1987
OHM Field Sampler's Training Course, 1986
First Aid, American Red Cross, 1983

Professional Affiliations

Member, American Board of Industrial Hygienists

Professional Certifications/Licenses

Certified Health-and-Safety Technologist, American Board of Industrial Hygienists, 1990
Licensed Wastewater Treatment Operator, New Jersey, 1990

MARK M. FRIAR

Mr. Friar has 7 years experience in direct supervision of on-site multidisciplinary (professional and laborer) oil and chemical cleanup personnel, and enforcement of all OSHA regulations.

His on-site experience includes development and execution of approved work plans, development of detailed cost estimates and approved site and spill safety plans, application of heavy equipment and field construction requirements, working in confined spaces, performance of assessments and evaluations at a hazardous waste site, scheduling, familiarity with and fulfilling OSHA requirements relative to site work, and coordinating transportation and disposal of hazardous wastes.

Experience

Mr. Friar's experience with environmental technologies includes:

- Drum recovery
- Groundwater treatment
- PCB cutting/bulking
- Hazardous waste disposal
- Shock-sensitive/explosive/ reactives handling and disposal
- Compressed gas cylinder identification/handling/ neutralization
- White phosphorous
- Air/water reactives handling
- Bioremediation
- Soil treatment
- Building demolition
- Wastewater treatment
- Landfill closures
- Contaminant sampling
- Underground recovery
- Filtration
- Dewatering
- Air monitoring
- Soil excavation
- Facility decontamination
- Derailments
- Drum repackaging
- Pesticide cleanups
- Labpacking

Detailed below are some of the projects in which Mr. Friar has been involved:

- Supervised operations involving dumpsite assessment, drum segregation and overpacking, debris removal and installation of perimeter fencing at the Turnpike Dump No. 5 site in Jersey City, New Jersey for the USEPA; contaminants involved were PCB, lead, petroleum hydrocarbons, unknown chemicals in drums and gas in cylinders, tires and general debris; responsibilities included implementation of work plan, site safety plan, OSC relations, field management and supervision of a foreman and cleanup crew; this ongoing project started in April 1991
- Supervised drum removal and labpack crushing at the Muratti Drum Dump site in Penuelas, Puerto Rico for the USEPA; contaminants involved were solvents, oils, sludge, paint and unknown chemicals; supervised a crew of one chemist, two sample technicians and four recovery technicians on this project from October to November 1990

- Supervised drum excavation, overpacking, sampling, and disposal of 980 drums of contaminated waste for the USEPA at the Chesnutis site in Beacon Falls, Connecticut; ninety waste streams were discovered to contain PCBs, pesticides, organics, inorganics, MEK, benzene, as well as other pollutants; implemented the work plan, and operated a 215 trackhoe equipped with a 360 degree grapppler, a 936 rubber tire loader, and a 580K trackhoe outfitted with a punch; crew consisted of 20 including recovery technicians, equipment operators, sample technicians, surveyors, and chemists; project started in July and was completed in November 1989
- Supervised buried drum and soil excavation for the USEPA at the Hooper Sands site in South Berwick, Maine, involving 2,000 cubic yards of soil and approximately four hundred drums; supervised a crew of eight including cleanup and sample technicians, and chemists; also operated the 215 trackhoe equipped with a 360 degree grapppler to excavate the drums; project began in November 1989 and ended in January 1990
- Supervised a landfill closure with a recovery system and a methane gas recovery at a pharmaceutical manufacturing facility for a confidential client in New Haven, Connecticut; it was discovered that the landfill's lead contamination was 100,000 ppm and was also polluted with sludge containing various solvents and hydrocarbons; supervised four equipment operators and ten recovery technicians; operated a 225 excavator, a 215 trackhoe, and a bulldozer; project began in January 1990 and was completed in three months
- Operated a 215 trackhoe for a tank excavation involving gasoline and fuel oil contamination at a manufacturing facility for a confidential client in Worcester, Massachusetts; this one week project was performed in April 1990
- Supervised the excavation of gasoline and fuel oil-contaminated soil around numerous one million gallon tanks at an oil refinery facility for a confidential client in Newark, New Jersey; supervised the team of equipment operators and recovery technicians; project started in April 1990, and ended one month later
- Supervised the excavation of soil contaminated with mercury at an aluminum manufacturing facility for a confidential client in Vineland, New Jersey; oversaw a crew of four recovery technicians during the project that was performed during May 1990
- Supervised for the USEPA at the Fried Industries site in East Brunswick, New Jersey, drum overpacking and sampling of a variety of pesticides, caustics, and acids with various volumes of these contaminants due to labpack and unknown crushing; supervised the sample technicians and equipment operators; project ended in mid-June 1990
- Supervised the dewatering of a lagoon; the installation of a plate and frame sludge press, and the initiation of a water treatment system for the USEPA at the Valley Plating site in Richmond, Virginia; the contaminants were heavy metals, cyanides, acids, caustics, chromium, and lead; oversaw a crew of seven including equipment operators and a recovery technician; three-week project began in June 1990
- Supervised the excavation of soil for bioremediation as a result of a diesel fuel spill for a railway corporation in Lancaster, Pennsylvania (confidential client); approximately 3,000 cubic yards were excavated, staged, and disposed; supervised a crew of equipment operators and a recovery technician, and operated a 215 trackhoe; project began in July 1990 and ended two months later

- Supervised building decontamination, consolidation of contaminated spilled fluids, sampling, and removal of hazardous wastes for the USEPA at the Silsonix site in Irvington, New Jersey; contaminants included a large quantity of acids and caustics, and a lesser volume of cyanide; oversaw a crew of 12 recovery technicians; project responsibility started in September 1990, and ended one month later

Specialized Training

OSHA site-safety and related training
Tank Patch course (40 hour), 1985
Asbestos Supervisory course (40 hour), 1988
Welding training, 1980
Automobile Mechanics training, 1978-1981

ROBERT HART

OHM REMEDIATION SERVICES CORP.

TITLE

Response Manager Level I

EXPERIENCE

Mr. Hart is qualified as Response Manager Level I based on his 5 years of direct, on-scene multidiscipline field experience in hazardous waste site cleanup and waste disposal activities. The contaminated media involved are air, water, soil, containers, oil and chemicals. All 5 of his years of onsite experience include direct supervision of multidisciplinary (professional and laborer) oil and chemical cleanup personnel. Mr. Hart's qualifications are based on 1/2 year as a Site Supervisor with OHM, 1/2 year as a Field Supervisor with S&D Environmental Services, and 4 years as Captain and Emergency Response Specialist with the Middlesex County Hazardous Materials Unit.

Mr. Hart on-site experience includes development and execution of approved work plans, development of detailed cost estimates and approved site and spill safety plans, application of heavy equipment and field construction requirements, working in confined spaces, performance of assessments and evaluations at hazardous waste sites, and scheduling.

His supervisory experience includes familiarity with and fulfilling OSHA requirements relative to site work, coordinating transportation and disposal of hazardous wastes, soliciting and receiving bids for services and materials, recommending the lowest qualified bidder, working with a client and/or OSC, acting as Site Safety Officer, report preparation, and 5 years as a supervisor at hazardous waste sites.

His experience with environmental remediation includes:

- Ground-water treatment
- Hazardous-waste disposal
- Contaminant sampling
- Underground storage tank removal
- Petroleum spills on waterways
- PCB decontamination/demolition
- Air monitoring
- Soil excavation
- Decontamination
- Derailments
- Drum repacking
- Compressed-gas cylinder identification/handling/neutralization

Projects Mr. Hart has supervised include the following:

Site Supervisor: Mr. Hart is supervising a PCB decontamination and demolition project for a sugar manufacturing company in Philadelphia, Pennsylvania. Approximately 500 tons of PCB-contaminated concrete and debris are being removed from the site. Mr. Hart's responsibilities include: supervising a crew of two equipment operators and four recovery technicians; conducting daily safety meetings; preparing project notes for project manager; and setting up and conducting personal air sampling for the crew. The project began in December 1992 and is ongoing.

Site Supervisor: In December 1992, Mr. Hart supervised the excavation of petroleum contaminated soils and silt from a drainage area for New Jersey Transit, Kearney, New Jersey. Mr. Hart supervised an on-site crew of two equipment operators and four recovery technicians. He managed all sampling, transportation, and disposal. He also interfaced with the client on project issues on a regular basis.

Site Supervisor: Mr. Hart supervised the removal of a 1,000 UST, containing #2 fuel oil, for a branch of a major retail chain in Kingston, New York. Mr. Hart supervised two recovery technicians and one equipment operator. He also wrote and implemented the site-specific health and safety plan, notified officials of tank removal activities, and prepared a removal summary report for the client. He also direct cost reporting activities for this November 1992 project.

Site Supervisor: Mr. Hart and his crew responded to an emergency incident involving a hydrochloric acid spill in Sayerville, New Jersey. Over 4,500 gallons of hydrochloric acid was neutralized, vacuumed, and cleaned up. Mr. Hart supervised the cleanup, and coordinated cleanup procedures with state and local officials. This included implementation of air monitoring and protective equipment programs. The crew consisted of two equipment operators and 10 recovery technicians. Project began and ended in November 1992.

Site Supervisor: Mr. Hart and his crew responded to an emergency incident involving the release of 2,500 gallons of diesel fuel from a locomotive. The crew contained the spilled diesel fuel, transferred the remaining fuel from the locomotive to drums, and excavated and drummed the contaminated soils. Mr. Hart supervised the crew, assisted in the fuel transfer, coordinated cleanup with the trainmaster, wrote and implemented the health and safety plan, provided daily progress and cost reports, and managed disposal of the drummed fuel and soils. He supervised one equipment operator and three laborers. This project occurred in November 1992.

Site Supervisor: Mr. Hart supervised the evening crew for a water treatment project in Valleyfield, Quebec, Canada. Approximately 2-million gallons of sulfide and heavy metal contaminated groundwater was treated at the site. Mr. Hart managed the operation of the water treatment system and crew during the night shift. This included inspection and maintenance procedures, sample collection and system monitoring, and coordination with client representatives. Project duration was from May 1992 to September 1992.

Field Supervisor: For the New Jersey Department of Environmental Protection and Energy (NJDEPE), Mr. Hart supervised the cleanup for 20 cubic yards of illegally dumped asbestos. Mr. Hart also coordinated disposal activities and worked with state and local agencies on cleanup procedures. The project began and ended in May 1992.

Captain/Emergency Response Specialist: For the Middlesex County (New Jersey) Hazardous Materials Unit, Mr. Hart responded to numerous emergency incidents involving hazardous materials, including oil spills and chemical fires. These incidents involved decontamination and laboratory packaging procedures. One particular incident, a fire at a plastics factory in Piscataway, New Jersey, required air monitoring, site entry, and decontamination procedures. Mr. Hart's responsibilities at the site included supervising and coordinating air monitoring for off-site evaluation, entries into the factory for reconnaissance and personnel decontamination, and coordination with federal, state, and local authorities. He supervised 10 respondents. He held this position for 1 year, 1989.

ACADEMIC BACKGROUND

A.A.S., Ophthalmic Science, Camden County College, 1983

**SPECIALIZED
TRAINING**

Technical and Regulatory Training in U.S.T. (NJDEPE), 1992
Site Safety Officer Training (OHM), 1992
Hazardous Materials Technician (N.J. State Police), 1991
Hazardous Materials Operations (N.J. State Police), 1990
Air Surveillance of Hazardous Materials (USEPA 165.4), 1990
Safety and Health Decision Making for Managers (USEPA 165.8), 1990
Hazardous Materials Incident Response Operations (USEPA 165.5), 1989
Incident Command System (National Fire Academy), 1989
Critical Incident Stress Debriefing (CISD of N.J.), 1989
Hazardous Materials Response for First Responders (USEPA 165.15), 1988
Tank Car Safety (Assn. of American Railroads), 1988
Hazardous Materials Response (Delaware Fire Academy), 1988
Air Monitoring Equipment (Middlesex County HAZ-MAT), 1987-1991
NFPA 1001 Fire Training (South Old Bridge Fire Dept.), 1980

**EMPLOYMENT
HISTORY****OHM Remediation Services Corp.**

September 1992 to present, Site Supervisor responsible for management of remediation and emergency response personnel, site safety, construction and equipment operation, cost and scheduling tracking, transportation and disposal coordination, regulatory compliance, report and estimate preparation, and client communication. Projects have included:

- Philadelphia, PA--Supervising PCB decontamination project at a sugar plant, December 1992 to present
- Kearney, NJ--Directed excavation of petroleum-contaminated soil, December 1992
- Kingston, NJ--Managed removal of fuel oil tank, November 1992
- Sayerville, NJ--Responded to 4,500 gallon hydrochloric acid spill, November 1992
- Buffalo, NY--Coordinated response and cleanup of 2,500 gallon diesel fuel spill from a locomotive, November 1992

S&D Environmental Services

January 1992 to September 1992, Field Supervisor responsible for supervising emergency cleanups and scheduling mitigation activities. Also prepared bids and work plans. Projects included:

- Valleyfield, Quebec--Supervised operation of treatment system for 2.5-million gallons of sulfide and heavy metal contaminated groundwater, May to September 1992
- Trenton, NJ--Managed cleanup of illegally dumped asbestos, May 1992

Middlesex County Hazardous Materials Unit

December 1987 to December 1991, Captain/Emergency Response Specialist responsible for responding to and mitigating hazardous materials emergencies and identifying and controlling sources of pollution. Responded to approximately 1,000 hazardous materials incidents. Interfaced with local police, fire, EMS, USEPA, USCG, and NJDEPE representatives. Projects included:

- Piscataway, NJ--Directed air monitoring program during fire cleanup at a plastics facility, June 1989

ROBERT HART

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REFERENCES

Mr. Richard Kozvib
Program Coordinator
Middlesex County Hazardous Materials Unit
1 Academy Drive
Sayerville, NJ
908-727-6626

Mr. Rob Schrader
NJDEPE, Emergency Response
Robbinsville, New Jersey
609-584-4150

Ms. Bonnie Green
USEPA Region II
Incident Response and Prevention
Edison, New Jersey
609-292-7172

PROFESSIONAL PROFILE

DAVID R. LEADENHAM

TITLE

QA/QC Manager

EXPERTISE

Field-operations management; project QA/QC

Mr. Leadenham joined OHM in 1984 and has been involved in over 250 projects ranging in value up to \$7.5 million. As an approved response manager under the criteria of the USEPA's ERCS contract, he has worked at more than 12 USEPA job sites and has worked closely with USEPA on-site coordinators to establish project procedures. He has conducted daily site-safety meetings and has extensive experience with government agencies and the USACE in emergency-response and remedial-action projects.

As QA/QC manager for OHM's Northeast Region, Mr. Leadenham is responsible for overseeing all current projects in the region. He assists the site supervisor in preplanning of operations and preparing site-safety plans. He provides documentation of project QA/QC and ensures that OHM provides overall quality service to the client.

Prior to joining OHM, Mr. Leadenham had 6 years' previous related experience and had established expertise in drum recovery and repackaging, PCB-cutting/bulking, dewatering, air-monitoring, demolition, equipment operation, and dredging. An overview of his experience with OHM follows:

- o Supervised an eight-man crew during the emergency response to a train derailment involving white phosphorus; directed the construction/fabrication of a reactor unit that effectively decontaminated over 1,500 cubic yards of contaminated soil during a 3-month period
- o Supervised and managed a crew of 70 during the 14-month decontamination of a facility contaminated with zinc; supervised water treatment, structure-washing, process-piping cleaning, and equipment decontamination
- o Supervised a 7-month project involving 70 million gallons of an oil/water-like substance containing unknown chemicals at the Kin-Buc Chemical landfill in Edison, New Jersey, a top priority Superfund site; detected chemicals which had leached into ground water threatening local water supplies; contained contamination using clay berms and flocculation of the water phase of the substance; supervised a 15-man crew in pumping, drum-staging, packaging, and loading operations
- o Supervised a 15-man crew and all activities involved in a 2-month project for the NJDEP using an innovative technique called "bottle-shredding"; consolidated compatible waste-streams from over 12,000 sample containers which resulted in reduced volume and lower disposal costs for the client

- o Assisted a six-man crew in the 1-day emergency transfer of highly flammable acetone from an overturned tanker on Interstate 87 in New York which had closed the highway to traffic
- o Supervised dredging of a millpond containing lead sediments; removed over 410 cubic yards of sludge after dewatering; directed nine workers in dredging operations and the construction of a temporary containment area
- o Supervised decontamination of a facility contaminated with mercury; managed a 40-man crew during all on-site activities which included on-site treatment, HEPA-vacuuming, and high-pressure washing
- o Supervised all site activities involved in the remediation of a site contaminated with malathion, parathion, and toxaphene; managed an eight-man crew who performed the work in Level A protection and completed the project in 2 months
- o Served as site supervisor for a USEPA Region III project in Massachusetts; responsible for the permanent soil-covering of a 23-acre asbestos landfill; implemented erosion-control measures; supervised 12 personnel during this 3-month project
- o Supervised a 45-man crew during the mercury decontamination of a four-story structure in Yorktown, Virginia; performed high-pressure washing and construction of an on-site, water-treatment system to treat run-off
- o Directed project to drain and remove more than 1,500 transformers from LeHigh Electric in Old Forge, Pennsylvania, a high-priority Superfund site; detected PCB contamination in levels ranging from 50 ppm to more than 500 ppm; supervised a crew of 15 in the performance of pumping and loading operations over a 3-month period
- o Supervised a 70-man crew during the 8-month decommissioning of a toluene diisocyanate plant in West Virginia which required process-pipe cleaning and removal, tank- and vessel-cleaning, asbestos-insulation removal, and on-site wastewater treatment

SPECIALIZED
TRAINING

OHM site-safety and related training

PROFESSIONAL PROFILE

KEVIN J. McMAHON, C.I.H.

<u>TITLE</u>	Manager, Health and Safety
<u>ACADEMIC BACKGROUND</u>	M.S., Environmental Health Science, Hunter College, 1984 B.S., Environmental Health Science, Hunter College, 1980
<u>EXPERTISE</u>	Industrial hygiene, hazardous waste-site audits, and field operations

Mr. McMahon joined OHM in 1987 with over 7 years' previous experience as an industrial hygienist in community, construction, and hazardous-waste operations.

As manager of the Health-and-Safety Department for OHM's Northeast Region for the past 2 years, his primary duties include conducting site and facility health-and-safety audits, developing and implementing site-safety plans, establishing industrial-hygiene consulting with outside companies, and proposal-writing. On certain projects, he assumes the duties of site-safety officer responsible for hazard recognition, evaluation, and control in both construction and industrial settings. Other responsibilities include coordination of medical-surveillance programs, marketing assistance, and employee training.

Prior to joining OHM, Mr. McMahon served as a senior industrial hygienist in the private sector. He developed and implemented comprehensive industrial-hygiene programs including employee-exposure monitoring to chemical and physical stressors, employee training, respiratory and personal protection, and ventilation certification. He also assisted in the development/implementation of chemical-hazard, communication-training programs including a chemical-safety trainer's course and manual. He was responsible for training approximately 3,000 employees.

As an industrial hygienist for the New York State Department of Health, Mr. McMahon managed the data-collection and surveillance activities of the Heavy-Metals and Occupational Lung Disease Registries. He undertook investigations of potential occupational and environmental-health problems in industry and the community and developed recommendations to correct or alleviate the health impact of the exposure.

Mr. McMahon was also a senior industrial hygienist for the New York State Department of Labor. In this capacity, he advised industries on compliance with OSHA standards, identified health hazards, and recommended methods of control.

He also served as an industrial-hygiene consultant on the recognition, evaluation, and control of occupational- and environmental-health problems and performed industrial-hygiene studies including air quality, ventilation, noise surveys, respirator-fit testing, and preparation of material-safety data sheets. He also conducted community environmental-health studies (e.g., ambient- and indoor-air quality, noise, stack sampling, and waste disposal).

**PROFESSIONAL
CERTIFICATIONS
& AFFILIATIONS**

Industrial Hygienist, American Board of Industrial Hygiene, 1986

Defensive Driving Instructor, NSC
Member, American Board of Industrial Hygiene
Member, American Academy of Industrial Hygiene
Member, American Industrial Hygiene Association

Member, American Conference of Governmental Industrial Hygienists

**SELECTED
PUBLICATIONS**

Tunnessen, Jr., W. W., K. J. McMahon, and M. Baser, 1987, "Acrodynia: Exposure to Mercury from Fluorescent Light Bulbs," Journal of Pediatrics, Vol. 79(5), pp. 786-789.

McMahon, K. J., 1985, "Insidious Inhalations," The Sciences, p. 12.

McMahon, K. J. and P. E. McManus, 1988, "Occupational Noise Exposure in the Printing Industry," Am Ind Hyg Assoc Journal, Vol. 49(1), pp. 34-37.

PROFESSIONAL PROFILE

MARK R. ELLIS

TITLE Site Supervisor/Heavy Equipment Operator

EXPERTISE Management and direction of hazardous-waste cleanup crews;
heavy-equipment operation

Mr. Ellis joined OHM in 1983 and worked as an operations foreman and site supervisor until 1987. He rejoined OHM as a site supervisor in mid-1989 with an additional 1-year supervisory experience with other environmental firms. He also has 2 years' general construction experience.

He has responded to literally hundreds of hazardous-materials incidents including train derailments for both the public and private sectors and is an approved response manager under the USEPA's Emergency Response Cleanup Services (ERCS) Zone I contract. His experience includes the supervision or participation in numerous Superfund remediations for the USEPA including the cleanup of radon-contaminated residences, bulking operations for acids and unknowns at an old distillery, drum excavations, and labpacking of pesticides.

Mr. Ellis's knowledge of hazardous materials-handling technologies includes alpha, beta, and gamma radiation decontamination; drum excavation and repacking; PCB and mercury decontamination; ether excavation and disposal; dewatering; filtration; wastewater and ground-water recovery and treatment; air-stripping of volatiles; herbicide/pesticide handling and disposal; labpack operations; containment and cleanup of oil spills; soil excavation; tank-testing, excavation, removal, and disposal; crushing and cold-cutting operations; compatibility testing; contaminant sampling; stabilization and fixation; handling and neutralization of acids for disposal; shock-sensitive materials handling and disposal; liquid-bulking operations; alcohols, acids, ketones, aldehydes, esters, etc., handling and disposal; compressed-gas cylinder identification, handling, and neutralization; and air-monitoring.

He is also an experienced heavy-equipment operator, licensed over-the-road driver, certified tank tester, and has completed over 500 hours of tank-management training.

Mr. Ellis's equipment expertise includes the setup and operation of various treatment systems and specialized equipment including air-strippers, filtration units, compatibility chambers/phase separators, chemical mixing tanks, and vacuum recovery units. He is also proficient in developing and implementing sampling and analytical procedures including operation of mobile laboratories and has served as a mobile laboratory technician on various environmental projects where expedient sampling and analysis turn-around time was critical.

To overview Mr. Ellis's project-specific experience, we have provided the following project highlights:

- o In September 1989, he was supervisor of an emergency response to a spill of 5,500 gallons of caustic soda (50/50 sodium hydroxide solution). The spill occurred during unloading of a rail tanker and spread approximately 1,000 yards along the track. Mr. Ellis directed two five-man crews (technicians, foremen, chemists) working 55 hours straight in neutralizing the spill with HCL and performing the cleanup to meet the requirements of the NJDEP.
- o In the summer of 1989, he directed an emergency-response, drum-removal project in Jersey City, New Jersey. He managed a 12-man crew including sample technicians, laborers, a foreman, and a chemist in removing, staging, and overpacking of approximately 300 drums. He also coordinated the sampling and analysis and transportation and disposal. Ten wastestreams including flammable organics, PCBs, and asbestos were present on site. Several unknown canisters were also discovered which required special handling procedures.
- o He supervised and participated in a facility decontamination in Paramus, New Jersey, involving the high-pressure lasering and scrubbing of floors and walls to remove inks, dyes, and resins in three laboratory rooms. Site activities included decontaminating the entire draining system and installing six monitoring wells. He monitored the progress of and assigned tasks to six laborers and two well drillers, traced and charted the cleanup of a drain system from blueprints, and coordinated the transportation and disposal of 14,000 gallons of wastewater generated during cleanup operations. This project was conducted in March 1987.
- o After a transformer fire spread PCB contamination throughout the Naval Air Rework Facility (NARF) in Norfolk, Virginia, Mr. Ellis lead an emergency response to decontaminate critical defense items. He supervised a 20-man crew and coordinated all on-site work including an extensive wipe-sampling program, decontamination of removable items in an on-site chamber, mobile laboratory analysis of samples, and cleanup of the two buildings contaminated by the fire. Decontamination techniques included high-pressure lasering with FREON which was recovered for reuse by filtering washwater through twin carbon cells. This 15-day project completed in June 1986 resulted in the decontamination of over \$20 million worth of defense items.
- o He was the night shift supervisor of an emergency cleanup of PCBs and mercury at a community college in Burlington, New Jersey. For this project conducted in October 1985, he directed ten laborers and one chemist in decontaminating the college's entire west wing. Project tasks included dismantling and disposing of ceiling tiles and the ventilation system, decontamination of carpeted floors, and scrubbing and

high-pressure lasering of hard surfaces. Mr. Ellis also coordinated the preliminary and verification sampling programs and implemented site-safety procedures.

- o In October 1985, Mr. Ellis supervised a project in Clifton, New Jersey, involving the neutralization of calcium hypochlorite. Forty 30-gallon fiber packs of calcium hypochlorite were placed in mixing vats and then neutralized by adding sodium phosphate and water. The pH was subsequently adjusted to 7, and the materials placed in 55-gallon drums for disposal as a base-neutral liquid.
- o At a waterworks in Wildwood, New Jersey, he oversaw the installation and operation of an underground recovery and treatment system for ground water contaminated by a 5,000-gallon gasoline spill. The system consisted of 12 underground recovery wells, two 12,000-gallon storage pools, and an air-stripper in line with a vapor-phase filter and a twin-cell, water-filtration system. After receipt of satisfactory analytical results, treated water was reinjected into the ground with a sprinkler system to continue the flushing process. Mr. Ellis managed eight laborers, a hydrogeologist, and an electrician in the setup and optimization of the system. He was also responsible for monitoring and adjusting flow rates, logging of sample results, and tracking of gallonage treated and costs.
- o He served as an operations foreman in April 1985 for a USEPA project in Landsdowne, Pennsylvania, under OHM's ERCS Zone I contract. The project consisted of removing radon dust (alpha and beta contamination) from several residences. He directed a four-man crew in the decontamination of a basement, garage, and one row of three-story homes. Materials requiring decontamination and disposal included furniture, clothing, tools, floors, etc. He instructed and supervised personnel in special handling procedures and oversaw wrapping and packaging of materials in special steel containers. He also monitored two subcontractors who installed a sprinkler system and collected readings on levels of radioactivity prior to disposal.
- o In Bellville, New Jersey, Mr. Ellis was foreman of a 17-man crew (chemists, equipment operators, and laborers) during an emergency response under OHM's contract with the NJDEP. The project required immediate removal and disposal of drums and containers of PCBs, acids, ketones, aldehydes, halogens, esters, alcohols, nerve gases, poison cylinders, shock-sensitives, and urinal nitrate. He assisted in the setup of a mobile laboratory, bottle-breaking and crushing units, and various pumping systems that were used in the bulking operation. He assigned personnel and equipment to daily work tasks and monitored the bulking, packaging, and disposal of the various wastestreams. This project was completed in April 1985.

- o For a PCB/dioxin decontamination project in New York City, he was the foreman of a ten-man cleanup and sampling crew. A transformer room at the facility had been contaminated with virgin oils ranging from 2,000 to 3,000 ppm. The room was isolated and scrubbed down three times with a Penetone solution. Wastewater was collected and transferred to drums for disposal. In addition, Mr. Ellis oversaw the decommissioning of transformers, verification sampling, and all site-safety procedures.
- o In June 1984, he directed the cleanup of a 23,000-gallon spill of No. 6 fuel oil in Winslow, New Jersey. He implemented initial containment measures and organized the cleanup which was accomplished using vacuum trucks and pumps; recovered oil was stored for separation. He also coordinated excavation of contaminated soils using four equipment operators and managed subcontractors used for backfilling and biological reseedling.
- o Mr. Ellis was foreman for a project in Croton-on-the-Hudson, New York, in which OHM installed a treatment system to remove PCBs and metals from wastewater treatment plant effluent. Contaminants were in the 1,200- to 2,000-ppm range. The system consisted of two twin carbon cells, two single-phase sand prefilters, and a 12,000-gallon retention pool. He managed a five-man crew in the setup and preliminary operation of the system, which filtered approximately 174,000 gallons per day. His other responsibilities included monitoring all systems, pumps, and flow meters; backwashing systems twice a day; changing out carbon cells when needed; removing, drying, and disposing of suspended solids/sludge; coordinating analysis of treated water and discharge of water meeting the cleanup criteria; and sampling of deep wells to determine influent contamination levels. He began this project in December 1983 and returned at various times until 1987.
- o He supervised a project for the USEPA at the Old Hickory Distillery in Philadelphia, Pennsylvania. He coordinated the activities of a 22-man crew (laborers, chemists, chemical engineer) in the bulking of wastestreams such as unknowns, acids, flammable organic liquids and solids, and low-level radiation (uranyl nitrate). He assisted in developing a sampling format and site-safety procedures, as well as planning for transportation and disposal. Additional project tasks involved pumping residual products from vessels, acid neutralization, crushing operations, and charting of product lines for residual contamination. This project occurred in March 1988.
- o He supervised the excavation of lead-contaminated soil in residential areas surrounding an old battery manufacturing facility. The affected areas covered approximately ten city blocks. He oversaw clearing operations, sampling and excavation depths, restoration of the landscape, and all safety procedures.

SPECIALIZED
TRAINING

OSHA 29 CFR 1910.120 training
OHM Site Supervisors' Training

Over 500 hours of specialized training in underground storage tanks including advanced courses and supervisors' training

Certified Petro-Tite Tank Tester

CPR, First Aid, and One-Man Rescue Techniques, American Red Cross

PROFESSIONAL PROFILE

THOMAS WESLEY JOYNER

<u>TITLE</u>	Transportation and Disposal Coordinator
<u>ACADEMIC BACKGROUND</u>	B.S., Natural Science, Pennsylvania State University, 1988
<u>EXPERTISE</u>	Environmental regulations and hazardous waste management

Mr. Joyner joined OHM bringing with him over 2 years of related experience. He is a member of the OHM northeast region transportation and disposal group and is responsible for preparing disposal analysis information, classification of wastestreams, investigating waste disposal options for proposals and projects, arranging transportation and disposal for same, and Interfacing with the USEPA and State regulatory agencies as required.

An overview of his experience is highlighted below.

As a waste approval coordinator, Mr. Joyner has provided technical support for sales and generators, determined laboratory analysis necessary for proper EPA and DOT classification, made recommendations on how and where to dispose of waste according to EPA regulations, interacted with TSDs and generators, recommended various treatment options for clients, and has performed wet chemical analysis.

In addition, Mr. Joyner worked as a site manager and contract director at the Philadelphia Naval Ship Yards. His responsibilities included supervision of site crews, preparation of paperwork (hazardous waste manifests, DRMO paperwork, and daily work schedules, packing lab chemicals, preparing bulk drums, transporting pickup points, remedial cleanup, contacting disposal facilities for profiling, packing and disposal guidelines, sampling materials, and bulking drums for tank truck removal.

He was also a line technician responsible for quality control and waste disposal of paper, plastics, fillers, and adhesives.

<u>SPECIALIZED TRAINING</u>	OHM site-safety and related training DOT waste shipping regulation DRMO contracting
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APPENDIX F - OHM SAMPLING PROGRAM

1.0 SAMPLING

The basic objective of any sampling program is to collect a sample which is representative of the media under investigation. More specifically, the purpose of sampling at hazardous-waste sites is to acquire information that will aid investigators in determining the presence and identification of the on-site contaminants and the extent to which these compounds have integrated into the surrounding environment. This information can then be used as support for further litigation or as input to remedial investigations and risk assessments.

The term "sample" has already been defined as a representative part of the media under investigation. Representativeness, however, is a relative term and must be carefully considered with several other criteria prior to the acquisition of samples. A list of the criteria is as follows:

- o Representativeness--This sample possesses the same properties as the material under consideration. The degree of resemblance of the sample to the material in question is determined by the desired qualities under investigation and analytical techniques used.
- o Sample size--The sample size should be chosen carefully in respect to physical properties of the entire object and the requirements and/or limitations of both sampling and analytical techniques.
- o Number and/or the frequency of subsample--Decisions on this consideration are based on the type of statistical information desired and the nature of the material collected.
- o Maintenance of sample integrity--The sample must retain the properties of the original medium conditions (at the time of sampling) through collection, transportation, and delivery to the analyst.

1.1 TYPES OF SAMPLES

Before defining the general sample types, the nature of the media or materials under investigation must be discussed.

Of least concern to the sampler are homogeneous materials. These materials are generally defined as having uniform composition throughout. In this case, any sample increment can be considered representative of the materials. On the other hand, heterogeneous samples present problems to the sampler due to the changes in the composition of the material over distance.

When discussing types of samples, it is important to distinguish between the type of media to be sampled and the sampling technique that yields a specific type of sample. In relation to the media to be sampled, the following are two basic types of samples to be considered:

- o Environmental samples--These samples include ambient air, soils, rivers, streams, or biota. They are generally diluted (in terms of pollutant concentration) and usually do not require the special handling procedures used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases have to be handled as hazardous samples.
- o Hazardous or concentrated samples--These samples are collected from drums, tanks, lagoons, pits, waste piles, fresh spills, etc., and require special handling procedures due to their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard. Care should be taken when handling and shipping any wastes believed to be concentrated, regardless of the degree.

In general, two basic types of sampling techniques are recognized, both of which can be used for either environmental or hazardous/concentrated samples: grab samples and composite samples.

1.1.1 Grab Samples

A grab sample is defined as a single sample representative of the specific location at a given point in time. The sample is collected all at once and at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples decreases.

1.1.2 Composite Samples

Composite samples are combinations of more than one sample collected at various sampling locations and/or different points in time. Analyses of composites yield an average value and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds to below detection limits.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing. Compositing is still often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed (after compatibility tests have been completed) to determine an average value over a number of different locations (e.g., a group of drums). This procedure provides data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations. An overview of the various sampling procedures is shown in the following table.

TABLE 1.1
OVERVIEW OF SAMPLING PROCEDURES

<u>Sample Type</u>	<u>Equipment</u>	<u>Reference</u>
Surface Soil	Spade-Scoop	EPA-600/4-84-076 December 1984
Subsurface Soil	Auger-Thin Wall Tube	EPA-600/4-84-076 December 1984
Subsurface Soil	Auger-Split Tube (Split Spoon)	EPA SW-611 December 1984
Sludge-Sediment	Scoop/Hand Corer Ponar Grab	EPA-600/4-84-076 December 1984
Bulk Materials	Scoop/Trier/Theif	EPA-600/4-84-076 December 1984
Surface Water	Various	EPA-600/4-84-076 December 1984
Containerized Liquids	Glass Tube/Coli-wasa	EPA-600/4-84-076 December 1984
Ground Water	Various	EPA-600/4-84-076 EPA SW-611
Ambient Air (Gases, Vapors, Aerosols)	Various	EPA-600/4-84-076 December 1984
Soil-gases, Vapors, Aerosols	Various	EPA-600/4-84-076 December 1984
Headspace Gases	Various	EPA-600/4-84-076

1.2 SAMPLING PLAN

Before any sampling activities begin, it is imperative that the purpose and goals of a program and the equipment, methodologies, and logistics to be used during the actual sampling be identified in the form of a work or sampling plan. This plan is developed when it becomes evident that a field investigation is necessary and should be initiated in conjunction with or immediately following the preliminary assessment. This plan should follow the QA protocols outlined in the QA plan as well as address the following items:

- o Existing work or background
- o Goals and scope of work
- o Organization of the field teams
- o Statistical strategy
- o QA/QC procedures
- o Safety considerations
- o Decontamination procedures

This list of sampling plan components is not all inclusive. Additional elements may be inserted or altered depending on the needs of the project. It should be understood that in emergency situations, personal judgement may have to be implemented. In any event, actions should be dictated by a plan to maintain logical and consistent order to the task.

1.3 STATISTICAL STRATEGY

Implementation of the proper statistical strategy depends on two essential points: 1) objectives or goals of the sampling, and 2) the amount of information available on the parameter(s) of interest (i.e., time, spatial distribution, variability). The following are among the different sampling schemes that could be chosen.

1.3.1 Random Sampling

Random sampling uses the theory of random chance probabilities to choose representative sample locations. Random sampling is generally employed when little information exists concerning the material, location, etc. It is most effective when the population of available sampling locations is large enough to lend statistical validity to the random selection process. Since one of the main difficulties with random sampling deals with achieving a truly random sample, it is advisable to use a table of random numbers to eliminate or reduce bias.

1.3.2 Systematic Sampling

Systematic sampling involves the collection of samples at predetermined, regular intervals. It is the most often employed sampling scheme; however, care must be exercised to avoid bias. If, for example, there are periodic variations in the material to be sampled such that the systematic plan becomes partially phased with these variations, bias will result. A systematic sampling plan is often the end result of an approach that began as random sampling. This is due to the tendency of investigators to subdivide large sample areas into smaller increments before randomizing.

1.3.3 Stratified Sampling

Data and background information made available from the preliminary site survey, prior investigations conducted on site, and/or experience with similar situations can be useful in reducing the number of samples needed to attain a specified precision. Stratified sampling essentially involves the division of the sample population into groups based on knowledge of sample characteristics at these divisions. The purpose of the approach is to increase the precision of the estimates made by sampling. This objective should be met if the divisions are selected in such a manner that the units within each division are more homogeneous than the total population. The procedures used basically involve handling each division in a simple random approach.

1.3.4 Judgement Sampling

A certain amount of judgement often enters into any sampling approach. In fact, a biased approach is the one most often employed when the intent is to document the presence of contamination (e.g., for enforcement purposes). Since judgement approaches tend to allow investigator bias to influence decisions, care must be exercised. Poor judgement can lead to poor quality data and improper conclusions. If judgement sampling is employed, it is generally advisable that enough samples be collected to lend credence to any conclusion drawn about the area under investigation because it is very difficult to actually measure sample accuracy. This is especially true for enforcement samples where the analytical results indicate no apparent sign of contamination. In such cases, it is important to reduce the chance of committing a Type II statistical error. The inability to measure sample accuracy makes it difficult to rule out Type II errors (i.e., the likelihood that contaminants are present at the site even if they are not found in the samples).

1.4 HOLDING TIMES AND SAMPLE PRESERVATION

The following table presents collection techniques, containers, preservation, holding time, and volume requirements for different sample types.

TABLE 1.2
SAMPLE PRESERVATION

<u>Parameter</u>	<u>Collection Technique</u>	<u>Container^a</u>	<u>Preservation</u>	<u>Holding Time</u>	<u>Minimum Required Volume (mL)</u>
Chloride	Grab or Composite	P, G	None required	28 days	50
Chromium VI	Grab or Composite	P, G	Cool, 4 C	24 hours	100
Conductance	Grab or Composite	P, G	Cool, 4 C	28 days	100
Cyanide	Grab or Composite	P, G	NaOH to pH greater than 12, 0.6g Asorbic acid ^d	14 days	500
Fluoride	Grab or Composite	P	None required	28 days	300
<u>Metals (Except Cr VI)</u>					
Dissolved	Grab or Composite	P, G	Filter on site, HNO ₃ to pH less than 2	6 months, except Hg--28 days	200
Suspended	Grab or Composite	P, G	Filter on site	6 months, except Hg--28 days	200
Total	Grab or Composite	P, G	HNO ₃ to pH less than 2	6 months, except Hg--28 days	100
<u>Nitrogen</u>					
Nitrate	Grab or Composite	P, G	Cool, 4 C H ₂ SO ₄ to pH less than 2	48 hours	100
Nitrite	Grab or Composite	P, G	Cool, 4 C, H ₂ SO ₄ to pH less than 2	48 hours	50

TABLE 1.2 (CONTINUED)

SAMPLE PRESERVATION

<u>Parameter</u>	<u>Collection Technique</u>	<u>Container^a</u>	<u>Preservation</u>	<u>Holding Time</u>	<u>Minimum Required Volume (mL)</u>
Oil and Grease	Grab only	G	Cool, 4 C, H ₂ SO ₄ to pH less than 2	28 days	1,000
<u>Organics</u>					
Extractables (base/neutrals and acids)	Grab or Composite	G, Teflon- lined cap	Cool, 4 C	7 days until 1,000 extraction; 30 days after extraction	
Purgeables (halocarbons- aromatics)	Grab only	G, Teflon- lined cap	Cool, 4 C	14 days	40
Purgeables (acrolein and acrylonitrile)	Grab only	G, Teflon- lined cap	Cool, 4 C	14 days	40
Pesticides and PCBs	Grab or Composite	G, Teflon- lined cap	Cool, 4 C	7 days until extraction; 30 days after extraction	250
pH	Grab only	P, G	Determine on site	2 hours	25
Phenol	Grab or Composite	G	Cool, 4 C, H ₂ SO ₄ to pH less than 2	24 hours	500
<u>Phosphorus</u>					
Orthophosphate	Grab or Composite	P, G	Filter on site Cool, 4 C	48 hours	50
Phosphorus, Total	Grab or Composite	P, G	Cool, 4 C, H ₂ SO ₄ to pH less than 2	28 days	50
Radioactivity	Grab or Composite	P, G	HNO ₃ to pH less than 2	6 months	1 gal
<u>Solids</u>					
Dissolved	Grab or Composite	P, G	Cool, 4 C	7 days	100
Suspended	Grab or Composite	P, G	Cool, 4 C	7 days	100
Total	Grab or Composite	P, G	Cool, 4 C	7 days	100

TABLE 1.2 (CONTINUED)

SAMPLE PRESERVATION

<u>Parameter</u>	<u>Collection Technique</u>	<u>Container^a</u>	<u>Preservation</u>	<u>Holding Time^b</u>	<u>Minimum Required Volume (mL)</u>
Sulfate	Grab or Composite	P, G	Cool, 4 C	28 days	50
TOC	Grab or Composite	G, Teflon-lined cap	Cool, 4 C, HCl to pH less than 2	28 days	25
TOX	Grab or Composite	G, Amber, Teflon-lined cap	Cool, 4 C, add 1 ml 0.1 M sodium sulfite	7 days	100

^a P = Polyethylene, G = Glass, Pro = Polypropylene

^b The holding times are those listed in Technical Additions to Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-055 and Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057.

1.5 QUALITY ASSURANCE SAMPLES

QA samples must be collected any time legal action is anticipated. It is recommended that QA samples accompany samples collected in all surveys in order to evaluate the quality of data generated. These additional samples are essential to any QC aspects of the project and may also assist in reducing costs associated with resampling brought about by container breakage, errors in the analytical procedure, or data confirmation. Following is a list of the types of QA samples required:

- o Sample blanks--Samples of deionized/distilled water, rinses of collection devices or containers, sampling media (e.g., sorbent), etc., that are handled in the same manner as the sample and subsequently analyzed to identify possible sources of contamination during collection, preservation, handling, or transport.
- o Co-located--Identical samples collected at the same time, in the same way, and contained, preserved, and transported in the same manner. These samples are often used to verify the reproducibility of the data.

- o Split samples--Duplicate samples given to the owner, operator, or person in charge for separate independent analysis.
- o Spiked samples--Duplicate samples that have a known amount of the substance of interest added to them. These samples are used to verify the accuracy of the analytical techniques and could be used as an indicator of sample quality during shipment to the laboratory.

All project sampling procedures are documented and kept on file with the project number, sample type, container and size, step-by-step procedure, parameters measured, preservatives required to extend storage, and equipment used.

1.6 TRACKING SAMPLES

An important link in the analysis of samples is documentation to prove that the sample results reported were derived from the sample that was actually taken. The sample tracking scheme begins with a chain-of-custody form that records the place, date, time, samplers, description of the sample(s) taken, purpose of analysis, and a unique sample number that is assigned to each sample. This chain of custody is signed for at each transfer. Copies of the chain of custody are kept with the sample(s) and are used to complete the master sample log for the laboratory.

The sample status sheet follows the sample through the analytical process of extraction, analysis, and report generation. Each step of the analysis is recorded. The extraction is documented with an extraction record that also documents QC spikes and blanks. QC data is recorded for the extraction and instrumentation on a separate form designed for that purpose. As the sample extract is physically moved from the extraction area to the instrumentation area, the records are also transferred. Data on the sample and QC spikes and blanks are recorded on the project data sheet. All forms are kept in the sample folder.

1.7 ANALYTICAL RECORDS

Laboratory personnel, whether working in a fixed-base or mobile laboratory, will maintain a bound, numbered logbook for drum samples and all other samples acquired. The following column headings are entered for each item of sample information:

- *1. Date--Date sample was obtained.
- *2. Log Number--Consecutive series of number in which every sample is assigned (transferred to sample jar before analysis).

- *3. Location--Description of area sampled (abbreviated form if sampled twice or more--log explaining locations and abbreviations should be attached to or written in front of the logbook).
- *4. Time--24-hour clock time sampled.
- *5. Samplers--Persons obtaining sample (always two--one at least witnessing even if not involved in actual act).
- 6. Type of Sample--Water, soil, air, sludge, etc.
- 7. Weight or Volume--Size of sample (20 ml, 200 gram, 1 oz., etc.).
- 8. Released by--Person turning sample into laboratory for analysis.
- 9. Accepted by--Person in laboratory responsible once sample has been released by field representative.
- 10. Date of Analysis--When sample is run through laboratory and result is determined.
- 11. Analysis by--Chemist who did analytical work.
- 12. Results--The drum log will consist of the parameters tested for, while the sample logbook will vary depending on disposal requirements and classification of waste stream.
- 13. Additional Comments--Space reserved for any other information concerning particular sample or special procedure or analysis and chain of custody of samples that leave site.
- 14. If an error is made in a project logbook assigned to one individual, that individual may make corrections simply by crossing a line through the error and entering the correct information. Changes made subsequently are dated and initialed.
- * This information should be included on the sample label.

Additional records maintained in the laboratory include:

- o Daily Log: A bound document of all laboratory activities including instrument maintenance, chemist working in laboratory, samples received;

a summary of sample analysis performed; problems encountered and solutions found; and QC sample preparation. This log is maintained on a daily basis by the QC Project Chemist.

- o QC Log: A bound laboratory logbook recording all QC data and results, standard preparations and specific instrument response calibration, and all samples analyzed.

1.8 RECEIVING SAMPLES (CHAIN OF CUSTODY)

The following are the procedures to be used when receiving samples.

- o Place samples directly into the refrigerator marked "Samples Only."
- o Check chain-of-custody form to see that all information is on the form. If not, find out the information and fill in on form.
- o After all samples are accounted for, sign your name in the correct "Accepted By" position for each form and place a checkmark in the appropriate corresponding column next to each sample. (If one sample is missing or broken, write "missing" or "broken" in place of the checkmark.)
- o If an error is discovered on a sample tag, custody record, or FDR, when possible the person who made the error should correct it. Corrections or insertions are made by inserting the word or abbreviation for "corrected", the date, and the correcting person's initials beside the correction. The procedure applies to words or figures inserted or added to a prior recorded statement.
- o If a sample tag is lost in shipment, a tag was never prepared for a sample(s), or a properly tagged sample was not transferred with a formal chain-of-custody record, the following procedure applies. A written statement is prepared detailing how the sample was collected, air-dispatched, or hand-transferred to the field or laboratory. The statement should include all pertinent information such as entries in field logbooks regarding the sample, whether the sample was in the sample collector's physical possession or in a locked compartment until hand-transferred to the laboratory, etc. Copies of the statement are distributed to the Response Manager, the Program Manager, and the appropriate ERCS project files.

- o Place the chain-of-custody forms, including the white copy, in the file basket marked "Samples To Be Logged In" in the laboratory supervisor's office. A project number will be assigned (if one is not already assigned to the samples) and the samples will be entered on the Daily Sample Status Sheet.
- o The analyst will enter the following information in the bound laboratory sample logbook:
 - Chain-of-custody number
 - Project number
 - Sample numbers
 - Sample descriptions
 - Requested analysis
 - Date samples were taken
 - Date samples were received into laboratory
- o The QC Officer is responsible for ensuring the above procedures are carried out.

1.9 SENDING SAMPLES FROM THE LABORATORY

The following are procedures to be used when sending samples from the laboratory.

- o Prepare a new chain-of-custody form. This form should contain information as to who sent the samples out, when, and where they were sent.
- o The white copy and yellow copy must accompany the samples being sent out. Keep a yellow copy in the sample file.
- o The person receiving the samples must sign their name and the initials of the company along with dates and checkmarks (initialing the forms will not be acceptable).
- o Have the receiving company send the white chain-of-custody form back to the main laboratory along with their test results on those samples.
- o Anything other than samples to disposal firms and samples for physical testing should have blanks and spikes.

1.10 FORMS FOR ROUTING SAMPLES THROUGH THE LABORATORY

Samples are routed and tracked through the laboratory via the following forms and procedures:

- o Proposed project form
- o Chain of custody
- o Daily sample status sheet
- o Inorganic digestion/analysis and QC record
- o Organic extraction/analysis and QC record
- o Laboratory data sheet

Information regarding each form and procedure is given below:

- o Proposed Project Form

The scope and timing of each project is listed on this sheet by the Project Coordinator. Any significant change in objectives, timing, or analysis procedure must be entered on this sheet and distributed to all senior staff involved in the project.

- o Chain of Custody

After the sample batch is logged in and replaced in the "New Samples" refrigerator, it will stay in storage until ready for analysis. When it is ready for analysis, the supervisor or chemist that removes it from the refrigerator must obtain the chain of custody from the secretary of Analytical Services, sign the "Accepted By" box, and return the originals (including the white copy) to the secretary. The remaining custody forms must accompany the samples through the system (chemistry, biology, instrumentation) which the sample moves.

- o Daily Sample Status Sheet

This form is used to keep administrative personnel abreast of the progress of each sample batch. Information on this sheet includes columns for the status of extraction (digestion), screening, analysis, report writing, and typing.

o Inorganic Digestion/Analysis and QC Record

This form must be filled out with each metals analysis. Information that is entered on this form includes:

- Sample and run numbers
- Volumes and dilutions
- Recoveries
- Instrument conditions for flame, cold vapor, or hydride analysis
- Results
- Digestion method

This form must be completed in full and accompany the chain of custody and data printouts from the Atomic Absorption Spectrophotometer and remain on file in the project folder. When this form is used properly, another chemist will be able to independently reproduce the analysis procedure.

o Organic Extraction/Analysis and QC Record

This form must be filled out with each analysis step. Information entered on this form includes:

- Sample and run numbers
- Volumes and dilutions
- Standards and spikes
- Recoveries
- Cleanup procedures
- Instrument conditions
- Results

This form must be completed in full and accompany the chain of custody and data printouts from the chromatographs, and remain on file in the project folder.

o Laboratory Data Sheet

All calculations necessary to convert instrument response units (absorbance, peak area, emf, etc.) to a final answer must be entered on this sheet. Run numbers of dates and times of analyses from integrators or data systems will be cross referenced to data sheets. This sheet must be included in the work folder.

1.11 ANALYTICAL PROCEDURES

The following are analytical procedures and specific analyses conducted on chemicals.

1.12 ON THE SPOT SITE TESTING (COMPATABILITY)

The objective of compatibility testing is to characterize and classify various unknown materials into compatible groups and subsequently simulate field bulking operations on a pilot scale to assure that unforeseen reactions do not occur during the actual field bulking. The unknown chemicals are separated into the following classifications:

<u>Liquids</u>		<u>Solids</u>	
R	- Air & Water Reactives	RS	- Air & Water Reactives
A	- Acids (pH 4)	A	- Acidic Solids
BN	- Base/Neutrals	BNS	- Base/Neutral Solids
<u>Liquids</u>		<u>Solids</u>	
CN	- Cyanides	CNS	- Cyanide Solids
CO	- Chlorinated Organics	FS	- Flammable Solids
FO	- Flammable Organics	OS	- Organic Solids
O	- Organics	OXS	- Oxidizing Solids
OX	- Oxidizers	PS	- Peroxide Solids
P	- Peroxide	SS	- Sulfide Solids
S	- Sulfides	PCB	- PCB-contaminated Waste
PCB	- PCB-contaminated Waste	RAD	- Radioactives
RAD	- Radioactives		

Drums are punctured by mechanical means and a representative sample is withdrawn by a glass dip tube. By using a dip tube, the sample is withdrawn in such a manner as to preserve the integrity of any layers which may be present in the drum. The sample is placed into an 8-ounce sample jar and recorded. Compatibility testing actually begins at the point the drum is sampled. The first test is conducted for radioactivity by means of a Geiger tube dosimeter and preliminary pH measurement by indicator strips. If the drums are not found to be radioactive, the sample is withdrawn and sent to the on-site mobile laboratory for compatibility testing in accordance with OHM's compatibility manual.

The sample is tested next for both solubility and reactivity simultaneously. With the addition of water to the sample, any reactivity will be noted immediately. If the sample remains stable, its solubility and/or density with respect to the water is noted. A second aliquot of sample is tested in a similar manner using hexane instead of water. Again, the solubility and/or density is noted visually. Samples which are hexane soluble and lighter than water are typically nonhalogenated solvents. Those which are hexane soluble and heavier than water are typically halogenated

solvents. This is confirmed with the Bielsstein test. Any aqueous samples are checked for pH again using a pH meter. Following the reactivity and solubility testing, the sample is tested for the presence of peroxides and oxidizers in general. The peroxide test is conducted using an indicating test strip and oxidizers are determined by an iodine/starch test. Following these tests, the sample is analyzed for cyanides using a chloramine-T/Pyridinebarbituric acid spot test. If the sample is positive, it is confirmed by use of a cyanide ion-selective electrode.

The final test consists of a gas chromatographic analysis for PCBs. The test is performed on bulked groups containing 5 to 10 samples. Bulk groups of greater than 10 drums dilute the sample beyond the range of the instrumentation to detect the 25 ppm cut-off level for PCBs.

Compatibility testing will be performed by the analytical laboratory.

1.13 CHEMICAL ANALYSIS FOR DISPOSAL

Disposal analysis will be performed at the OHM laboratory. The amount and types of analysis performed will depend on the waste type and the disposal company's(ies') requirements. All analysis performed will employ the QC procedures described in the EPA's "Handbook for Analytical Quality Control in Water and Wastewater Laboratories" (EPA 600/4-79-019), EMSL-Cincinnati, March, 1979.

1.14 LEACHING TESTS

To demonstrate that a wastestream is or is not hazardous by EP Toxicity characteristics, the EP Toxicity Extraction Procedure will be used as described in 75.261, Appendix II, for parameters listed in 75.261, Table 1. For co-disposal of a wastestream with municipal refuse, the EP Toxicity Extraction Procedure or the ASTM Method B Leaching Procedure may be used. For segregated disposal of a wastestream, either the ASTM Method A leachate or the EP Toxicity Extraction Procedure leachate may be used. The analyses should be conducted on samples in the condition in which they are to be treated, stored, or disposed.

The following constituents and parameters are required in the leachate analysis unless they are not present in the total analysis, or if the total analysis of the waste indicates less than 0.001 mg/kg or 0.01 mg/l for a given constituent or parameter, then that constituent or parameter need not be analyzed. All results are reported in mg/l or as otherwise specified in method.

- a. pH - EPA 600/4-79-020, Method 150.1 (report as pH units)
- b. Oil and grease - EPA 600/4-79-020, Method 413.1

- c. Ammonia-Nitrogen - EPA 600/4-79-020, Method 350.1 or 350.2
- d. Phenolics - EPA 600/4-79-020, Methods 420.1 or 420.2
- e. Cyanide - EPA SW-846, Method 9010 and Std. Methods, Method 412-E (16th Ed.)
- f. Total metals - EPA SW-846, General Requirements, Method 6010 and EPA 600/4-79-020, Metals by ICAP, Section 200.7
 - i. Antimony, EPA SW-846, Method 6010
 - ii. Arsenic, EPA SW-846, Method 7061
 - iii. Barium, EPA SW-846, Method 6010
 - iv. Cadmium, EPA SW-846, Method 6010
 - v. Chromium, EPA SW-846, Method 6010
 - vi. Hexavalent Chromium, EPA 600/4-79-020, Method 218.4
 - vii. Lead, EPA SW-846, Method 6010
 - viii. Mercury, EPA SW-846, Method 7470
 - ix. Nickel, EPA SW-846, Method 6010
 - x. Selenium, EPA SW-846, Method 7741
 - xi. Silver, EPA SW-846, Method 6010
 - xii. Copper, EPA 600/4-79-020, Method 6010
 - xiii. Molybdenum, EPA 600/4-79-020, Method 6010
- g. Organics - For methods of analysis for specific compounds, refer to 75.261, Table A, Pages 75 and 68, and the EPA's "Test Methods for Evaluating Solid Waste" (SE 846), or other published procedures (Other methods may be acceptable if approved by the department.)
- h. Total organic halogen - Adsorption with microcoulometric detection
 - i. COD - EPA 600/4-79-020, Method 410.1 or 410.4
 - j. TOC - EPA 600/4-79-020, Method 415.1
 - k. Total volatile residue - EPA 600/4-79-020, Method 160.4
 - l. Total filterable residue - EPA 600/4-79-020, Method 160.1

1.15 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

OHM's analytical laboratories adhere to established protocols and QC checks regarding three QC classification levels. All data generated at each level will be derived using sound scientific practices. The complexity of environmental

problems and the types of analyses and numbers of possible analyses that are required for each program require that QC guidelines be approached at several levels. This means that a given QC level is more suitable than another for certain projects, but not that one QC level is "better" than another.

The three QC classification levels and their subcategories are as follows:

I. Quantitative

A. USEPA Protocol

B. Good Laboratory Practices (GLP) Protocol

The QC protocol to be used for these samples are those deemed prudent and sufficient according to GLP. All sample batches will be accompanied by a spike, blank, and replicates. All standards will be of primary standard grade or traceable to NBS standards. Shewhart control charts will be used to track the recovery of the spike, but results will not be rejected for out-of-control situations if substantiated by reproducibility studies. Definitions of LOD and LOQ will be defined as $LOD = 3S.D.$, $LOQ = 5S.D.$

II. Semiquantitative

Level II: Semiquantitative

The QC protocol used for this category will include blanks, but spikes and replicates may or may not be used. Instruments will be calibrated with working standards of primary standard grade or be traceable to NBS standards. Results will be given in one of two ways: 1) in terms of ranges covering the entire concentration range of interest; and 2) by means of a one significant figure value \pm its percent relative standard deviation. No results will be given with less than an order-of-magnitude range.

Level III: Qualitative

A QC protocol will be applied that is appropriate only to qualitative data. Method blanks will be run. Numbers will not be reported. Any compound detected above the method LOD will be reported by a "+" mark.

The report and associated data tables will indicate whether or not the component identification was accomplished via comparison of the Gas Chromatographic (GC) and/or Mass Spectrometric (MS) properties of the analyte(s) analyzed during

the same batch of samples. In addition, criteria for qualitative data require that a spike into the blank matrix be performed in order to prove that the LOD quoted is realistic. Each data table will be labeled "Qualitative".

1.16 ORDER IN WHICH CRITERIA ARE TO BE APPLIED AT LEVEL I:
QUANTITATIVE (USEPA AND GLP CRITERIA)

Laboratory QC will follow USEPA protocols. This includes the use of Shewhart Control Charts for spike recovery QC, the use of the relative percent difference for replicate and standard QC, an interlaboratory QC check, and the analysis of standards, blanks, and samples. Guidelines published in the ACS publication titled "Guidelines for Data Acquisition and Data Quality Control Evaluation in Environmental Chemistry," Anal. Chem., 52, 2242 (1980) will also be strictly followed with respect to LOD/LOQ criteria.

There is a significant probability that standards, spikes, blanks, and/or replicates from the field and/or the laboratory will fail the requisite QC tests on a periodic basis. This cannot be avoided. If this occurs, a decision must be made to either lower the level of certification of the resultant data, or to take new samples and/or institute new analyses.

In the following discussion of USEPA criteria, the symbols used represent the results of analysis according to the scheme:

A_1 = first replicate of Sample A
 A_2 = second replicate of Sample A
 $A^2 = (A_1 + A_2) \div 2$
 B = sample taken simultaneously (split) with Sample A
 B_{SF} = field spike into Sample B
 B_{SL} = laboratory spike into Sample B
 D_F = field spike into distilled water
 D_L = laboratory spike into distilled water
 T = true value for all spikes

Laboratory personnel must perform the following steps for QA when Level I: Quantitative (USEPA Criteria) are to be utilized. These are applied in whole or in-part to other levels/criteria after review of program requirements. In many applications of Level I: Quantitative (GLP Criteria), only percent recovery ($D_L/T \times 100$ or $[B_{SL} - B]/T \times 100$) relative percent difference $\frac{(A_1 - A_2)}{A} \times 100$ criteria may be required.

- a. Analyze the blank and instrument calibration standard. If results are unsatisfactory, resolve problems before continuing.

- b. Analyze sample D_p . If the percent recovery of T is unsatisfactory, create a similarly spiked, distilled-water sample D_s and analyze to test for a systematic error in the laboratory or fundamental problems with the spike. If the percent recovery of T from D_s is satisfactory, then systematic error occurred before the samples reached the laboratory. Corrective actions, as outlined in Section 13.0 of this document, must be employed.
- c. Analyze samples B and B_{SF} . If B is greater than $10T$, disregard the remainder of this step and proceed to Step d. If the percent recovery of T from B_{SF} is unsatisfactory (see Section 12.1), spike an aliquot of sample B the same way in the laboratory so that a similar recovery can be anticipated. Analyze this sample B_{SL} to test for immediate sample interferences or a bad background result B. If the percent recovery from B_{SL} is satisfactory, then the interference must require a longer delay before analysis, or other special conditions not present in the laboratory, in order to have a noticeable effect upon recovery of the spike.
- d. Analyze A_1 and A_2 . If the absolute (unsigned) difference between these results exceeds the critical value, then precision is out of control and corrective actions as outline in Section 13.0 of this document must be enacted.
- e. Calculate the absolute difference between A_1 and B. If it is unsatisfactory, the field sample procedure did not provide representative samples.

If initial results at each of the laboratory steps were satisfactory, then the validity of the related data has been indisputably established. If results at any step are unsatisfactory, then the problem must be identified and corrective actions, as indicated in Section 13.0 of this document, must be carried out. Laboratory problems may just require that the analyses be repeated, but field problems will usually require new samples.

The laboratory spikes B_{SL} and D_s are the only analyses that may not be necessary. All other analyses must be done either once per day or once per batch of ten, whichever is more frequent.

1.16.1 Cautionary Notes For The Use of These Criteria

The above criteria will be strictly applied in the case of Level I: Quantitative (USEPA Criteria).

The approach detailed in these criteria will be used as guidelines for other levels of data. It is recognized that GLP involves the examination of standards, blanks, and spikes before analyzing samples. This procedure will be followed, but guidelines will be adapted to the requirements of specific projects within the limitations imposed in the definitions of the levels.

The criteria for Level I: Quantitative (GLP Criteria) will always include D_L/T , $A_1 - A_2$, and $B_{SL} - B/T$.

1.17 SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL CRITERIA

A short summary of the key aspects of the criteria for QA/QC protocol is given below:

- o Checklist for laboratory acceptance
- o Checklist for laboratory adherence
- o Description of analysis methods
- o QA program

A presample analysis site inspection using the acceptance checklist must be satisfied. During the analysis phase, site inspection(s) will be made using the adherence checklists.

1.18 DATA REDUCTION, VALIDATION, AND REPORTING

Analytical results are compiled by the analysts and supervisors and are entered in the log sheets discussed in Section 7.0. Calculations are entered on data sheets and instrument-generated tables and plots are included in the work file along with the chain of custody. These data are summarized in a report which is forwarded to the Project Coordinator. The Project Coordinator will generate a project status report. The report will include:

- o Cover sheet
- o Summary (highlights of relevant data)
- o Introduction (including description of project)
- o Methodology (including references to specific literature)
- o Results and discussion
- o QA/QC statement (following the format given below)

Before this report is released, it will be signed by a senior-level staff member capable of performing an independent review of the data and content of the report.

Each report issued at Level I: Quantitative (USEPA Criteria) will have the following statement on the cover:

Level I: Quantitative (USEPA Criteria)

These data have been collected and analyzed in strict accordance with procedures defined in "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," USEPA 600/4-79-019, EMSL-Cincinnati, March 1979.

Each report issued at Level I: Quantitative (GLP Criteria) will have the following statement on the cover:

Level I: Quantitative (GLP Criteria)

These data have been analyzed with due regard for Good Laboratory Quality Control Practices. The criteria used have been detailed in the report.

Each report issued at Level II: Semiquantitative will have the following statement on the cover:

Level II: Semiquantitative

These data are semiquantitative. Project protocol did not require the high level of QC necessary for quantitative data, or the analysis method may be semiquantitative in nature.

Each report issued at Level III: Qualitative will have the following statement on the cover:

Level III: Qualitative

These data are qualitative, not quantitative. QC procedures necessary for the generation of quantitative data have not been performed. Quantitative values cannot be assigned to these data.

After all data has been acquired, the sample report is generated. The completeness of all records is verified and calculations are checked. The quality of the data is evaluated upon the basis of QC data. Only when these steps have been properly sequenced and reviewed is data reported.

1.19 QUALITY ASSURANCE AUDITS, REPORTS, AND PREVENTATIVE MAINTENANCE PROCEDURES

The QC organization requires extensive documentation of activities and progress. These documents, notes, logs, and forms are reviewed on a daily basis by the designated QC authority within each group. Each morning this group leader meets with all members of his group to discuss activities and strategies for the day's progress. Any discrepancies or problems relating to that group's functional quality will be addressed at this time and rectified. All QC group authorities will meet once a week with the supervisory engineer to discuss the upcoming week's activities and the intergroup requirements to formulate the sequence of events during that week.

Within each group a series of documents/forms exists. The most critical among these documents is the daily project notes.

1.20 PROJECT NOTES

The daily project notes are prepared concurrent with daily activities. The following items are included in the notes each day:

- o Meeting notes
- o Special orders and activities received
- o Materials delivered to project site
- o Materials shipped from project site
- o Operation of any and all equipment used during workday and function
- o Names of all people on the site including OHM personnel
- o Current weather
- o Visitors by agencies or representatives of the client
- o All activities of the day
- o Telephone conversations and content
- o Drawings and sketches of job situations or equipment used

1.21 DAILY REPORTS

Daily reports are filled out on site by an administrative assistance summarizing the daily notes.

At all times, the QC engineer shall have ultimate responsibility for the completion, completeness, and enforcement of the QC forms and document, as well as enforcement of subordinate QC task leader functions.

1.22 SPECIFIC PROCEDURES TO ASSESS PRECISION AND ACCURACY

Reliability in analytical determination is maintained through strict adherence to QC procedures. Procedures are designed to control both the accuracy and precision of analytical results.

Depending on the level of certification of the data, a known method spike is routinely analyzed to assure the accuracy of results. The procedure is to run this standard analysis with each lot of samples sent to the laboratory. If more than 20 individual analyses are made, additional standards will be analyzed at a rate of one standard per 20 analyses. Some procedures call for the use of either a surrogate spike or the standard addition of a known quantity of the analyte to a split of the sample being analyzed.

Control charts are prepared using an estimate of the spike recovery obtained from the literature or determined by repeated analyses run in the laboratory. Each time the analyst runs a method spike, the result is entered on the control table. If a standard addition technique is used, a plot of instrument response versus added analyte concentration is made in order to determine analyte concentration in the original sample.

Replicate analyses are performed on at least 5 percent of the samples processed by the laboratory. A record of the precision of most analyses is kept by calculating and plotting the relative percent difference.

Blanks are also run with each batch of samples or individual sample analyzed, regardless of the level of certification of the data.

The purpose of the use of spikes, blanks, and replicates is to provide a sound scientific basis from which the degree of certification of the resultant data can be objectively concluded. These are not management decisions, but follow naturally from the results of the above QC procedures.

1.23 CRITERIA FOR ACCURACY OF RESULTS

The following are the procedures for assuring analytical accuracy.

- o Shewhart Charts--In the 1920s, Dr. Walter A. Shewhart developed the theory of control charts as a basic method for evaluating the quality of

products from manufacturing processes. Dr. Shewhart's work has been accepted as the standard method for environmental analytical QC. The recovery of standards is judged against criteria based on a plot of percent recovery of method spikes (Y axis) for each batch analysis (X axis). The criteria are developed as follows:

- Development of Data Set--A body of spike recovery data for a coherent sample set (similar matrix and concentration range) developed in-house or by suitable outside laboratories is examined to determine if outliers are present. This is done using the Dixon or Student's T Test for Outliers. After outliers have been eliminated, a mean and standard deviation is calculated and the data set is examined to see that at least 50 percent of the data is within ± 1 standard deviation (S.D.) of the mean. (This last step is suggested as a guideline; it is not a requirement.)
- Preparation of the Graph--The percent recovery (Y axis) is plotted versus sample batch. Lines are drawn indicating the mean value and ± 2 S.D. and ± 3 S.D. levels. These are the "warning limits" and "control limits", respectively.
- Graphical Analysis of the Data--In applying the control chart, the following condition would indicate an out-of-control situation:
 - o Any point beyond the control limits

When an out-of-control situation occurs, analyses must be stopped until the problem has been identified and resolved, after which the frequency should be increased for the next few percent recovery QC checks.

The problem and its solution must be documented and all analyses since the last in-control point must be repeated or discarded. When a warning limit is exceeded, i.e., 1) any point beyond the working limits but within the control limits, and/or 2) seven successive points on the same side of the mean value, the area supervisor must be notified and the situation evaluated. The Project Coordinator must be notified of any corrective actions taken and the samples potentially affected.

- Cautionary Notes in the Use of this Chart

- o The Shewhart criteria must be applied to Level I: Quantitative data.
- o These criteria may be used for Level II: Semiquantitative data.
- o These criteria will not be used for Level III: Qualitative data.
- o If percent recovery is sensitive to changes in matrix and/or concentration, separate data sets must be used for each distinct case.

o Table of Statistics from EPA Water Pollution Performance Evaluation Studies

- The USEPA conducted six water pollution performance evaluation studies during the period ending June 1981. Data from those studies is summarized in "Table of Statistics from EPA Water Pollution (WP) Performance Evaluation Studies, USEPA-EMSL (Cincinnati), June 1981." These tables give the following information:

- o Substances studies: trace metals, minerals, nutrients, PCBs, pesticides, organics, miscellaneous
- o Number of studies: up to six each
- o Concentration ranges: up to three orders-of-magnitude
- o Information provided: number of reported values, mean recovery, standard deviation, regression equations

With the above data, warning and control limits can be calculated for each substance studied, at each concentration range studied. These calculations provide information that is mathematically and functionally equivalent to Shewhart Charts. This table is kept by the QA/QC Officer and the Director of Technical Services.

- Cautionary Notes in the Use of this Table

- o These data are applicable only to water samples.

- o These tables must be applied to Level I: Quantitative data.
- o These tables may be used for Level II: Semiquantitative data.
- o These tables will not be used for Level III: Qualitative data.

1.24 CRITERIA FOR PRECISION

An extension of the Shewhart Chart is the use of the relative percent difference (RPD) to measure precision:

$$RPD = \frac{A - B}{\frac{(A + B)}{2}} \times 100 \text{ percent where A and B are duplicate analyses}$$

One replicate must be run per batch of samples or one per batch of 20 samples according to the judgement of the Project Coordinator.

1.25 CRITERIA FOR REJECTION OF OUTLYING MEASUREMENTS

According to the American Society for Testing and Materials (ASTM),

An outlying observation, or "outlier," is one that appears to deviate markedly from other members of the sample in which it occurs. In this connection, the following two alternatives are of interest.

An outlying observation may be merely an extreme manifestation of the random variability inherent in the data. If this is true, the value should be retained and processed in the same manner as the other observations in the sample.

On the other hand, an outlying observation may be the result of gross deviation from prescribed experimental procedure or an error in calculating or recording the numerical value. In such cases, it may be desirable to institute an investigation to ascertain the reason for the aberrant value. The observation may even actually be rejected as a result of the investigation, though not necessarily so. At any rate, in subsequent data analysis the outlier or outliers will be recognized as probably being from a different population than that of the other sample values.

When the experimenter is clearly aware that a gross deviation from prescribed experimental procedure has taken place, the resultant observation should be discarded, whether or not it agrees with the rest of the data and without recourse to statistical tests for outliers.

(ASTM STP E178-80 from the Annual Book of ASTM Standards, Volume 14.02, page 139, 1983.)

The procedure to be used for screening analytical data (analysis of blanks, multiple runs of calibration standards, duplicate samples, and replicated analyses of single samples) is as follows:

- o Physical reason known for outlier(s)
 - Reject observation, or
 - Correct observation on physical grounds, or
 - Reject observation and make additional observations
- o Physical reason unknown--use statistical test
 - If test indicates rejection of observation, then:
 - o Reject observation
 - o Note in QC log
 - o Possibly make additional observations
 - o Try to discover a physical cause
 - If test does not indicate rejection of observation, then:
 - o Accept value as due to normal variation in analytical or sampling process
 - o Do not ignore physical causes which may be discovered later

It should be pointed out that almost all criteria for outliers are based on an assumed underlying normal (Gaussian) population or distribution. When the data are not normally or approximately normally distributed, the probabilities associated with these tests will be different. Until such time as criteria not sensitive to the normality assumption are developed, the experimenter is cautioned against interpreting the probabilities too literally.

Some sets of data, such as peak areas from runs of method blanks on a gas chromatograph, may be lognormally distributed. This possibility may be checked by use of the stem and leaf display and by taking logs of the data and testing for normality.

Testing for normality will be accomplished by use of the W test developed by Shapiro and Wilk¹ for $n = 50$ or by D'Agostino's² test for n is greater than or equal to 50. These tests are described in Statistical Methods for Environmental Pollution Monitoring, Richard O. Gilbert, Van Nostrand-Reinhold, 1987.

Rejection of outliers in lognormal data may be accomplished by taking logs of the data and using one of the following statistical tests for outliers.

The T test is a powerful and widely accepted test for outliers. Another very useful test, which requires much less calculation, is the Dixon test. Both of these tests are recommended by the ASTM (STP E178-80), the Association of Official Analytical Chemists (Statistical Manual of Official Analytical Chemists, W. J. Youden and E. H. Steiner, 1975), and the USEPA (Quality Assurance Handbook for Air Pollution Measurement Systems: Volume 1 Principles, Appendix F, EPA 600/9-76-05).

Both of these tests will ordinarily be used at the 1 percent significance level. The use of these tests is best illustrated in the above-mentioned ASTM practice.

1.26 CRITERIA FOR ESTABLISHING LIMITS OF DETECTION (LOD) AND LIMITS OF QUANTITATION (LOQ)

1.26.1 LIMIT OF DETECTION

The LOD, also known as the method detection limit (MDL), "is the minimum concentration that can be measured reliably. It is determined by measuring the variability of replicate measurements at zero or near zero sample concentration. Depending on the method, this may be accomplished by measuring a zero concentration reference material, the sample carrier, unexposed sample reagent or extract, or similar zero-concentration matrix."³ Alternatively, for gas

¹ Shapiro, S. S. and M. B. Wilk, 1965. An analysis of variance test for normality (complete samples), *Biometrika* 52:591-611.

² D'Agostino, R. B., 1971. An omnibus test of normality for moderate and large size samples, *Biometrika* 58:341-348.

³ "Quality Assurance for Environmental Measurements," ASTM STP 867, page 46, 1985.

chromatographic methods, the noise level adjacent in retention time to the analyte peak(s) may be used. This is important when there is significant noise contributed by the sample matrix, which would necessitate a higher LOD than would be otherwise indicated.

"The MDL [LOD] is reported in concentration units as the standard deviation of the replicate zero (or near zero) measurements multiplied by the appropriate Student's t-value (for a one-tailed test at 99 percent confidence) for the number of replicates taken". The LOD then is a function of the blank noise level, the number of blank noise determinations, and the slope and intercept of the calibration curve.

In terms of analyte signal, $LOD = X_b + t_{0.01, df} S_b$, where X_b is the mean noise level, S_b is the standard deviation of the blank noise, and df is the number of determinations of the blank noise level minus 1 (degrees of freedom). It may be that the blank noise is lognormally distributed. In this case, an LOD in the log data should be calculated and converted to the scale of the original data by taking its antilog.

The LOD, in concentration units, is then found by substituting the LOD in analyte signal into the expression for the calibration curve. Care must be taken to ensure the calibration data fits the calibration curve in the region of the LOD. When the calibration curve does not fit the data near the LOD, the concentration value of the LOD is best determined by linear interpolation between the points $(X_b, 0)$ and (X_{low}, C_{low}) , where X_b is the mean blank noise level, X_{low} is the mean signal from repeated analyses of the low standard, and C_{low} is the concentration of the low standard.

When careful determination of the LOD is important to the QA/QC objectives of the project, a standard should be made at the LOD concentration and analyzed to confirm that it can be detected.

In many cases, the lowest analyte level of interest may be well above the LOD set by instrumental noise. In fact, instrument or integrator settings may be such that background noise is not observable. In these cases a provisional LOD may be set at the concentration of the lowest standard which can clearly be seen on the instrument.

1.26.2 Limit of Quantitation

The numerical significance of the apparent analyte concentration increases as the analyte signal increases above the LOD. As a minimum criterion, the region for quantitation should be clearly above the LOD. Additionally, the calibration function should give a good fit to the calibration data in the region of the LOQ. These two criteria determine the LOQ in various applications.

The standard criterion for the LOQ being clearly above the LOD is that the LOQ should be far enough above the LOD that the LOD does not fall inside a 95 percent confidence interval around the LOQ. Depending on the application, tighter intervals around the regression line (corresponding to lower levels of confidence), or higher levels of confidence (corresponding to wider intervals around the regression line), may be used. For a given set of calibration data, the LOQ is raised or lowered by raising or lowering the confidence level.

The width of a confidence interval at a given level of confidence around a concentration estimate from the calibration curve is determined by the residuals ($r_i = y_i - \hat{y}_i$, where $\hat{y}_i = C[x_i]$ is the calibration function). There may be a relationship between the fit \hat{y}_i and the absolute value of the residuals, r_i . If this is the case, it will be evident from a plot of the residuals against the fit. An increasing trend indicates that the size of the residuals is proportional to the value of the fit.

The two cases, residuals not related to the fit and residuals proportional to the fit, determine which estimator is used for the regression error. When the residuals are not related to the fit, the standard estimate of error is used. It is calculated as follows:

$$S_e = \sqrt{\sum_{i=1}^n r_i^2 / (n-m)},$$

where n = the total number of analyses of calibration standards and m = the number of parameters estimated in the calibration function (e.g., two for the linear function $y = a + bx$, three for the quadratic $y = a + bx + cx^2$). Note that S_e is reduced by division by the square root of the degrees of freedom ($n-m$). When the residuals are proportional to the fit, they can be standardized by division by the fit ($r_i = r_i / \hat{y}_i$). The standardized residuals r_i are then substituted into the above expression for the standard estimate of error to give a relative standard estimate of error, S_e . The standard estimate of error for a given regression estimate then is $S = S_e(y) = S_e \hat{y}$. A 95 percent confidence interval around a regression estimate then is given by $\hat{y} \pm t_{95, d.f.} S_e$, where d.f. = number of runs of calibration standards, not including analyses of blanks, minus the number of parameters estimated in the calibration function.

The first criterion for the LOQ then becomes LOQ is greater than or equal to \hat{y} , where \hat{y} is chosen such that $\hat{y} \pm t_{95, d.f.} S_e$ is greater than or equal to LOD. It is important to remember that S_e may be a function of \hat{y} .

The second criterion for the LOQ essentially says that where the calibration curve does not fit the calibration data, it does not provide a good guide to quantitation. Plotting the residuals against the fit gives a magnifying-glass

view of departures from the fit. There are two conditions to look out for: 1) a systematic departure of the residuals from the fit (i.e., a residual pattern indicating that an additional term should be added to the fit) and 2) large residuals at the lower end of the calibration curve.

For the first condition, readjusting the fit should solve the problem. For the second, either the LOQ should be adjusted upward to the point where the calibration function begins to give a good fit, or if enough analyses of low calibration standards have been made, another calibration function may be used for the low range.

In any case, after the LOQ has been estimated, a standard at the LOQ should be made up and analyzed to confirm that the calibration function is adequate for quantitation at the LOQ. If there is a problem, a new calibration function should be computed using the additional data from analysis of the new standard.

What constitutes a good fit is determined by the lack of pattern in residuals and the required precision in the regression estimate at a given level of confidence.

- o Additional Risks in Low Recovery Methods--The recovery of a method is derived from the measurement of "spiked blanks." These may be controls or simulated field samples containing varied known added concentrations (C) of the analyte. The recovery is determined by using

$$\% \text{ recovery} = \frac{C \text{ (found)}}{C \text{ (added)}} \times 100$$

where C (found) is based on the net analyte signal for the "spiked" blank. High recoveries leave intrinsically little room for variability in the recovery itself. Conversely, as the recovery falls, the measurement process becomes more dependent on the knowledge of the precision of the actual recovery at that concentration. In carrying out recovery studies, the analyst should know that analyte added to a blank sample may behave differently (typically, showing higher recovery) from naturally incorporated analyte in the sample. In this case, the method of standard additions tends to lead toward erroneously low values. Whenever possible, testing should include experiments with homogenous working standards containing known amounts of naturally incorporated analyte. Unfortunately, the frequent lack of such specified samples or standards is an important limitation in modern trace organic analysis.

Alternatively, the use of low recovery methods may be satisfactorily applied in the "region of quantitation" only if the accuracy and precision are established at a specified confidence limit. Under these conditions, the measurements of field samples, when corrected for recovery, can accurately indicate the true analyte concentration. Analysis methods that yield mean recoveries of less than 60 percent may be unreliable due to the difficulty of obtaining its value accurately. Data that fits into this category should be reviewed carefully in order to ascertain its reliability.

- o Cautionary Notes for the Use of These Criteria--
The LOD, LOQ, and percent recovery criteria are to be applied as defined for Level I: Quantitative (USEPA Criteria).

The LOD criteria should be applied as defined to Levels II and III data, but the LOQ criterion is not applicable.

1.27 CORRECTIVE ACTION

If for any reason a breakdown in the QA occurs, corrective action must be taken to restore analytical operations and/or evaluate problem areas.

The following information flow and decision-making process check systems serve as a means of corrective action.

- o Information Flow and Decision-making Process for Level IA: Quantitative (USEPA Criteria)
 1. Does chain of custody match sample labels?
 - o No: Determine correct information or resample
 - o Yes: Proceed to Step 2
 2. Do sample containers, preservatives, and holding time match EPA requirements?
 - o No: Resample or lower to Level IC: Quantitative (GLP Criteria) or Level II: Semiquantitative
 - o Yes: Proceed to Step 3

3. Track all relevant analysis parameters and custody signatures. Report any procedure variations to supervisor. Was variation acceptable?
 - o No: Restart analysis, resample, or downgrade to Level IC: Quantitative (GLP Criteria) or Level II: Semiquantitative
 - o Yes: Proceed to Step 4
4. Run field blank(s), field spike(s), duplicates, and traceable standards. Document each step. Report data to QA/QC Officer. Is data in control on Shewhart and RPD charts?
 - o No: Investigate problem including running of laboratory blanks and spikes, restart analysis, resample, or downgrade to Level IC or Level II
 - o Yes: Proceed to Step 5
5. Run samples and calculate data on worksheet. Any calculation errors found during independent check of worksheet?
 - o Yes: Check all data and recheck
 - o No: Report data and Level of Certification
- o Information Flow and Decision-making Process for Level IC: Quantitative (GLP Criteria)
 1. Does chain of custody match sample label?
 - o No: Determine correct information or resample
 - o Yes: Proceed to Step 2
 2. Do sample containers, preservations, and holding time match EPA requirements?
 - o No: Notify supervisor and QA/QC Officer then proceed to Step 3 only after clearance to do so
 - o Yes: Proceed to Step 3

3. Track all relevant analysis parameters and custody signatures. Report any procedural variations to supervisor. Was variation acceptable?
 - o No: Restart analysis, resample, or downgrade to Level II: Semiquantitative
 - o Yes: Proceed to Step 4
 4. Run field blank(s), field spike(s), duplicates, and traceable standards. Document each step. Report data to QA/QC Officer. Is data in control on Shewhart and RPD charts or within control limits set by Project Manager?
 - o No: Investigate problem including running of laboratory blanks and spikes, restart analysis, resample, or downgrade to Level II
 - o Yes: Proceed to Step 5
 5. Run samples and calculate data on worksheet. Any calculation errors found during independent check of worksheet?
 - o Yes: Check all data and recheck
 - o No: Report data and Level of Certification
- o Information Flow and Decision-making Process for Level II: Semiquantitative Data
1. Does chain of custody match sample label?
 - o No: Determine correct information or resample
 - o Yes: Proceed to Step 2
 2. Do sample containers, preservations, and holding time match EPA requirements?
 - o No: Notify supervisor then proceed to Step 3
 - o Yes: Proceed to Step 3

3. Track all relevant analysis parameters and custody signatures. Report any procedural variations to supervisor. Was variation acceptable?
 - o No: Restart analysis, resample, or downgrade to Level III: Qualitative
 - o Yes: Proceed to Step 4
 4. Run blank(s) and standards. Document each step. Report data to supervisor. Is data within limits set by Project Manager?
 - o No: Investigate problems, restart analysis, resample, or downgrade to Level III: Qualitative
 - o Yes: Proceed to Step 5
 5. Run samples and calculate data on worksheet. Any calculation errors found during independent check of worksheet?
 - o Yes: Check all data and recheck
 - o No: Report data and Level of Certification
- o Information Flow and Decision-making Process for Level III: Qualitative Data
1. Does chain of custody match sample label?
 - o No: Determine correct information or resample
 - o Yes: Proceed to Step 2
 2. Do sample containers, preservations, and holding time match EPA requirements?
 - o No: Notify supervisor then proceed to Step 3
 - o Yes: Proceed to Step 3
 3. Track all relevant analysis parameters and custody signatures. Report any procedural variations to supervisor. Was variation acceptable?
 - o No: Restart analysis or resample
 - o Yes: Proceed to Step 4

4. Run blank(s) and standards. Document each step. Report data to supervisor. Are qualitative identifications reasonable?

- o No: Investigate problem, restart analysis, or resample

- o Yes: Proceed to Step 5

5. Run samples and calculate data on worksheet. Any calculation errors found during independent check of worksheet?

- o Yes: Check all data and recheck

- o No: Report data and detail methodology to ensure that data will not be considered as quantitative